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MORLEY'S
DAIRY FARMERS ENCYCLOPEDIA

(Illustrated)

ALAN MORLEY

(Author of "The Right Way to Pig Keeping and Breeding")

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FOREWORD

Britain is most suitable for livestock, and cattle production forms the most important branch of our Agriculture. A sound knowledge of the methods of breeding, feeding and management of cattle is therefore one of our main requirements. In the past much of the practical knowledge concerning livestock has been handed on from generation to generation of farmers by example or by word of mouth. In recent years, however, much progress has been made in scientific investigations on subjects which have a bearing on the cattle industry. One of the great needs to-day is to apply this new knowledge to the practical management of cattle and to blend it with the traditional practical knowledge so as to obtain progress in the industry. This, Mr. Alan Morley sets out to do in the following pages in a concise way which should appeal to the practical man who wants to apply the knowledge. It should also be most useful to the younger generation of farmers, now frequently coming into the industry from other spheres of life, in giving them the essentials of good practical management together with modern scientific methods.

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Reader in Agric. Physiology, Cambridge

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THE DAIRY INDUSTRY

THE foundation of the Milk Marketing Board in 1913 put an end to insecurity for the dairy farmer. Previously many farmers in outlying areas received as little as sixpence per gallon for their milk and remained in the industry only by accepting frugal living standards.

Before the Second World War, Britain was self-supporting in liquid milk and had a small summer surplus which was processed to butter, cheese and other products. This was only a tiny percentage of our requirements and over the year we imported 1½ gallons as manufactured products for every gallon produced at home.

Despite increased production, milk had for a time to be rationed because of greater demand owing to the appreciation of its value by the public, the subsidising of supplies to children and schools, and since we cannot now import processed milk freely owing to currency difficulties.

These facts, coupled with fixed price policies, justify the belief that, while the present peak demand may not always be maintained, a lengthy period of prosperity lies ahead. They are in themselves sufficient incentive for increased efficiency. The average yield of cows in Britain is unnecessarily low and the cost of production too high, but many farmers, employing advanced methods, have shown that we need not consider this state of affairs to be permanent.

Membership of the M.M.B. is compulsory and the majority of farmers sell their milk wholesale to the Board, receiving monthly payment. Some, however, are granted a licence to retail milk straight from the farm. Farmers working in this way—they are termed producer-retailers—pay a levy to the Board on sales. A still further form of agreement is given to farmers in remote grassland areas where the production of milk for the fluid market is

impracticable and where cheesemaking is the most suitable activity. Other than this, there is practically no commercial processing on farms and consequently the farmer, and this book, are mainly concerned with liquid milk up to the point at which it leaves the farm.

On almost all our farms it is easier and cheaper to produce milk in summer than in winter, and to encourage producers to keep their gallonage steady throughout the seasons, increased prices are offered at the more difficult times of the year. Although the farmer receives a steady seasonal price, the Board sales are effected at varying prices. Dairy companies making cheese, condensed milk and other products pay less than those buying milk for retail sale and are thus able to sell at an economic level. But for this, it would be impossible, in normal times, to compete with the vast grazing countries, and the outlet for the summer surplus would be lost.

There are some 160,000 members of the M.M.B., owning, on the average, 15 cows each, while Scotland has 10,000 producers and 250,000 cows. The figures given below, taken from a few selected years, show the trend of the industry: —

Million Gallons

Winter.	Summer.	Total	Winter milk as percentage of total.
*	*	*	
385	471	856	45%
487	632	1,119	43·5%
581	662	1,243	46·7%

From figures supplied by the Milk Marketing Board

CHAPTER I

MILK

Description of Milk

Milk is the perfect food for its intended purpose. It contains all the known food factors and three of its constituents—butter fat, casein and lactose—are found in no other food. While milk is intended by Nature as the sole food for young mammals, it forms a valuable supplement in the diet of adults. About six pints daily would keep a man in health and fit for normal work.

The milk of all mammals contains the same constituents, but the proportion in which they occur varies in each species. The variations are related to the speed of growth of the young and the living conditions natural to the species. Proteins and minerals are essential for growth and fat for warmth. Young pigs and pups double their birthweight in the first ten days of life, and to provide for this rapid increase, the milk of sows and bitches is rich in the growth factors. Similarly, reindeer and whales which rear their young under conditions of intense cold, produce milk of high fat content. The human infant is slowest to mature and woman's milk is, as would be expected, poorest in protein and ash values. It is normal in butter fat but very rich in lactose and it is for this reason that sugar is added to cow milk fed babies.

It is interesting to note that, while all milk is the same chemically, the milk of one species may not be suitable for the young of another, even though the constituents are found in similar proportions. Thus, although a calf will do well on goats' milk, kids do not usually thrive when given cows' milk.

The following table shows the analyses of average samples of the milk of various species:—

	Cow	Sow	Mare	Ewe	Goat	Ass	Bitch	Cat	Rein-deer	Whale	Human
	%	%	%	%	%	%	%	%	%	%	%
Butter Fat	3.75	4.50	1.20	8.60	4.00	2.00	8 50	4.60	22.50	45.00	3.25
Protein	3.40	7.23	2.03	6 70	3.80	2.10	6.84	7.20	10.25	10.00	1.65
Lactose	4.75	3.16	5.73	4.30	4.20	6.49	4.11	3.11	2.50	1.00	6.96
Ash	0.75	1.05	0.35	0.96	0.80	0.26	1.08	1.05	1.45	0.46	0.22
Water	87.35	84.06	90.69	79.44	87.20	89.15	79.47	84.04	63.30	43.54	87.92

From these figures, the differences may be clearly seen; of course, considerable variations exist in individual samples from each species.

Cows' milk is in almost universal use in highly developed territories, but in countries not suited to their support, the milk of camels, goats and asses is valued. In Britain, many people consider goats' milk to be specially valuable, but as is shown in the table above, it is little richer than average cows' milk and indeed falls below the quality produced by some of the dairy breeds. Asses' milk is nearest to human and has been used successfully in the treatment of ailing children.

The Udder and Milk Secretion

Milk is produced in the udder, the general mass of which is made up of mammary, fatty and connective tissues. While the udder of a cow has the appearance of a single bag, it is made up of four separate quarters or glands. The quarters are not visibly separated from each other, though a ligament runs through the bag, separating the right from the left hand pairs. This ligament assists, with the connective tissue and other ligaments placed round the perimeter of the vessel, in keeping it attached to the body of the cow. When the ligaments weaken through age or high production, the udder drops and is said to be pendulous.

It is within the mammary tissue that milk is secreted. This tissue occupies the upper part of the udder and consists of the alveoli, or minute cellular spheres, each of

which has a lumen or space in the centre. An outlet is provided by a tiny duct. The alveoli are contractile and are clustered like bunches of grapes, the ducts connecting to larger ducts which resemble the stem and its branches.

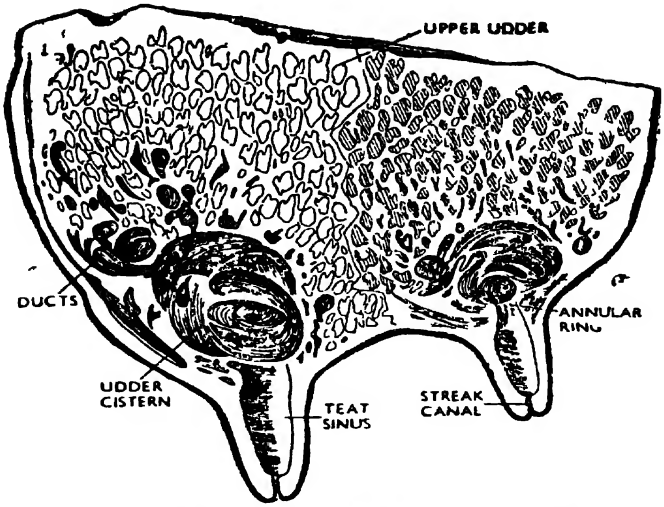
The udder is freely supplied with blood. From the heart it reaches the vessel by arteries placed on the insides of the thighs and returns by several veins. Each alveolus is maintained by blood vessels of arterial and venous types, and as the blood passes through, the nutrients are extracted and milk is formed. What happens in the metamorphosis is not completely known and only a general picture has been obtained.

It is computed that 1,200 lbs. of blood pass through the udder every hour. This rate gives 28,800 lbs. of blood in 24 hours, and if the cow produces 6 gallons (60 lbs.) milk in that time, the nutrients have been extracted from a flow of 480 lbs. blood to produce 1 lb. milk. This is about the average rate for mammals, but as there are few cows producing 6 gallons per day, the majority cannot be described as efficient. In spite of this, cows are the most suitable for our purposes, one of the main reasons being that much of their milk is produced from bulky foods which cannot be used for other purposes.

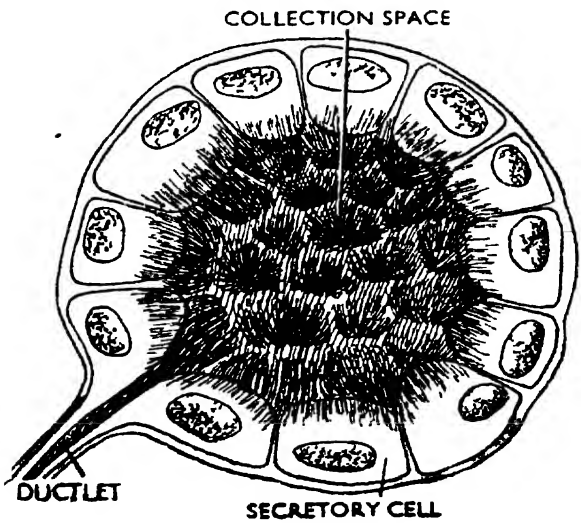
The changes which occur in the conversion of blood nutrients are highly complex, as the substances found in milk do not closely resemble the blood or food nutrients. The changes are brought about by the combined action of hormones, or blood messengers, sent out by the pituitary gland and the ovaries.

As milk is produced, it enters the lumen of the alveoli and is discharged through the ducts into the larger duct system and thence to the milk cisterns, which occupy the lower parts of the udder. These are situated above the teats. The teats are hollow, the cavity ending in a narrow streak canal, through which the milk is ejected. In some cows, the top of the cavity or sinus is restricted by an annular muscle ring, while at the bottom of the teat there is a sphincter muscle which prevents leakage of milk.

It was previously thought that milk was produced only under the stimulus of milking or suckling, but it has been shown by American workers that secretion is continuous. This was proved when a cow of known yield was



Diagrammatic longitudinal section of udder



Diagrammatic section of alveolus

slaughtered before she was due to be milked. The udder was cut away and milked out by hand and then washed out, and a total 10% in excess of the anticipated yield was obtained.

In the period between milkings, much of the milk is retained within the mammary tissues, and only careful stimulation of the udder will effect its release. In the experiment quoted above, only 40% was got by manipulating the teats and this may be taken as approximately the quantity which had dropped to the lower parts of the udder—the milk cisterns and the larger ducts. The surplus of 10% which was obtained shows that even with careful milking, the cow does not surrender the entire amount secreted.

The connective tissue of the udder supports the alveoli and forms the framework of the whole structure. Apart from a minimum required for protective purposes, fatty tissue is of no value. If present in excess, the pressure caused retards the development and work of the alveoli.

Development of the Udder

Foetal development of the udder and teats is apparent at birth. From then until the onset of puberty, a slight increase in size results from the accumulation of fat. When the animal attains sexual maturity, the ovarian hormone, oestrogen (which also causes the desire for mating), promotes the growth of the duct system, and although this is continued with each heat period, it is only with pregnancy that appreciable growth is seen. Midway through the first gestation, the alveoli develop and, later, secrete a viscous fluid which, at parturition, becomes colostrum. Colostrum is the specialised milk necessary for the nutrition of the newborn calf. It is produced for about four days, when the milk gradually becomes normal. The hormones progestin (ovarian) and prolactin (pituitary) promote this development and secretion, and when their activity ceases the lactation ends and the alveoli atrophy. Udder growth continues through succeeding lactations until the animal is mature.

It is partly because of the breakdown of the alveoli and the necessity for rebuilding them that cows require rest

and good feeding between the end of one lactation and the beginning of the next.

Injections of the appropriate hormones increase the growth of heifer udders and may promote milk secretion in virgin females. To date work in this direction has no commercial significance.

The glands mentioned here—the pituitary gland and the ovaries, are endocrine glands. Glands of this type eject their hormonal secretions into the blood stream, to be picked up by all other glands and tissues which are sensitive to the stimulant. The male testicles are also endocrine.

The pituitary is described as the master gland, as it has a strong influence on the others of this type.

The Constituents of Milk

The fat of milk is complex and contains about twelve different fatty acids. It has the highest commercial value of all the constituents and the proportion contained forms the principal measure of milk quality. It influences the colour and viscosity, and a deep yellow-coloured milk with good creaming properties finds a ready sale.

Butter fat is in the form of globules floating in the milk and is easily separated from the other constituents. Some breeds of cattle and individual animals produce milk with large globules, but the majority of breeds and cows give small globules With all breeds, they tend to become smaller as the lactation advances.

Large globules rise to the surface more readily and milk constituted in this way is more suitable for butter production. Milk with smaller fat globules is, however, more easily digested and, as such, is best for babies.

Fat is the most perishable of the milk constituents and so the preservation of whole milk for long periods presents many problems. Research workers are seeking means to allay deterioration.

Proteins. Casein is the principal milk protein. Smaller quantities of albumin and globulin are present.

Casein gives milk its white colour and coagulates when sour. The little solid flecks appearing on tea when slightly soured milk is used are casein. Casein is used in the manufacture of buttons and plastic materials.

Lactose. Though a sugar, lactose is not as sweet as the cane or beet types. It acts beneficially on the intestines and is used in the compounding of medicines.

Ash. Many different minerals, all essential for the bone development and general health of young animals, are found in milk. They occur only in minute quantities and, especially in the case of iron, are inadequate for the calves' needs after the first few weeks of life. It is therefore important that other foods containing minerals be made available to calves as soon as they are able to deal with them—usually at three weeks.

Vitamins. Milk contains most of the known vitamins. Colostrum contains about ten times the amount of the anti-infective Vitamin *A* present in mature milk and this greatly assists the calf to resist disease.

Water. The water of milk acts as a means of suspension and distribution of the food factors and, chemically, has no more apparent value than normal water. In practice, however, separated milk—that is, milk from which the fat has been removed—gives better results in calf rearing than dried separated milk reconstituted with water, though theoretically the two forms are identical. And to make the matter more obscure, doctors assert from hospital experience that babies thrive better on dried whole milk than on milk in its natural state. This does not, of course, apply to babies suckled by their mothers.

The Characters of Milk

Colour. Milk is basically white, but most samples have a yellow tinge. The deeper the yellow colour, the more it is appreciated by the public. Yellow colour is associated with the fat and is derived from carotene, which is produced from the green colouring matter of plants (chlorophyll). The following factors influence the degree of colouring:—

1. *Butter Fat content.* As carotene associates with fat, milk having a greater quantity of fat dispersed through it bears a deeper colour than milk produced, under similar conditions, but with less fat.
2. *Feeding of the cow.* Cows fed on green foods receive more carotene than those on winter rations of hay, roots and cereal grains. Summer milk produced by

grazing cows is therefore deeper coloured than that produced in winter, unless adequate quantities of green food are given throughout the year.

3. *Breed and Individuality.* The Jersey, Guernsey and Devon breeds (these will be described with the other breeds in Chapter II) produce milk of a richer colour than the others. Their skin and body fat are also yellow. Varying reasons for this have been given, but it appears that those giving white milk—their body fat is also white—convert carotene in varying degrees of completeness to Vitamin *A*, which imparts no colour. The yellow-fat breeds store carotene without conversion, and passing it on to the consumer, leave him with the work of converting it within his own body. Cows within a breed also vary to some degree in this character.

It must be emphasised that—other things being equal—comparing for butter fat and other solids and the food the cows receive, there is no difference in nutritional values between a white and a yellow sample, despite the contrary belief of the public. The tendency to yellow body fat is a serious drawback in beef production, as the public is just as strong in condemning yellow fat as it is in praise of yellow milk, and with no more valid reason.

Flavour of milk. This is derived from the combination of fat, lactose and salt contained. As a cow nears the end of her lactation, the fall in lactose is accompanied by a rise in the chloride content, with a consequent adjustment in the taste. This "salty" taste is also apparent in milk from cows affected by mastitis.

Milk readily absorbs taints from outside sources and these "external" taints may be gathered via the cow or directly from strong smelling substances. Thus, if a cow merely smells onions, the milk will have an onion taste and if exposed to the fumes of paraffin oil or strong disinfectants, the flavour will be absorbed by the milk.

Feeding of the cows also influences the taste of milk Foods causing taints are dealt with in Chapter X.

To this list must be added the effects of souring by bacteriological actions, most of which have a pronounced effect on the flavour as well as, in some cases, the odour. Normally, milk has no odour.

Viscosity. Casein and fat mainly account for the viscous character. Because of the effect on fat, milk which has been heated becomes less viscous. Agitation also makes milk appear "thinner", but in each case, the fat is merely more widely dispersed. Freezing has the same effect.

Yield. The amount of milk given by cows varies widely. The highest known production is 4,503 gallons in 365 days by a British Friesian and goodly numbers, representing several breeds, have reached 60—85 tons (10.32 lbs. per gallon) in their lifetime. A good cow yields rather more than her body weight in a month. Against this, many specimens in our herds even to-day produce as little as 300 gallons in a lactation.

No single factor governs a cow's abilities. The breed, ancestry, individuality, age, health and environment all share responsibility. It is probable that the degree of efficiency of hormonal secretions also has an important bearing.

Legal Aspects

The Presumptive Legal Standards set for milk decree that it must contain at least 3% Butter Fat and 8.5% of the other solids, or solids-not-fat, as they are termed. Milk must be sold as it comes from the cow, and it is just as illegal to add substances to improve the colour as it is to remove fat or add water.

If milk is found to be below the Standards, the seller is presumed to have diluted it and, in complete reversal of normal judicial procedure, he has the reponsibility of proving himself innocent. If the sub-standard milk is genuine, the farmer may clear himself by an "appeal to the cow". In this event, the cows are milked and the milk tested under official supervision, and if it is still below the legal requirements, no criminal offence has been committed. Unless there is an improvement, the farmer may, however, lose his license to produce milk

Approximately 10% of cows fail to reach the Standards in butter fat, with rather more failing in solids-not-fat. Various circumstances could cause milk to fall genuinely below the Standards, and the means of assuring "safe" milk are dealt with in Chapter XII.

Many cases of poor quality are caused by the criminal dilution of milk. Milk testers can, with certainty, detect even the smallest addition of water and, apart from the dishonesty which should be sufficient deterrent, the danger of being caught is too great to make the risk worth while. Many tricks are tried to avoid punishment, but they are all well known to the responsible authorities. For instance, farmers have been known to bore a hole in the water tubes of the milk cooler and, when caught, to "discover" this as the "accidental" cause of the additional water being in the milk, but the dodge is, fortunately, quite worn out.

Further legal points are that the farmer must register with the local council, who may refuse a licence if the conditions on the farm or dairy do not satisfy the regulations regarding cleanliness. A number of rules have been set up which, unfortunately, vary in the different counties, and anyone starting farming should acquaint himself with the local conditions.

Grades of Milk

There are several specially designated grades of milk The conditions governing the production and sale of each grade are set out briefly in the Appendix 3. Further discussion is superfluous here as the regulations are subject to change and, in any case, those starting a dairy farm or contemplating a change to another grade would require to consult the local licensing authorities to find out if the premises are suited to the grade considered.

There are, however, two main classifications which should be discussed. These are:—

1. Milk from tuberculin tested herds v. milk from non-tested herds.
2. Pasteurised milk v. raw milk.

1. Although Scotland leads England in Tuberculin Tested (T.T.) herds, the number of such herds in Britain is less than 10% of the total. This is a bad feature and but for the introduction of pasteurisation, would have serious results on the health of the people.

T.T. milk must come from herds which are periodically subjected to veterinary inspection and passed as clear. A

bonus of fourpence is at present paid on each gallon from these herds, and, apart from the extra income, it is clearly a public duty for all farmers to build up disease free herds. Milk not sold under a T.T. licence is produced by herds not subject to compulsory examination, though any cow known to be suffering from certain forms of tuberculosis must be withdrawn from the herd.

Milk from T.T. herds is sold both raw and pasteurised.

2. While it is true that some farmers are still opposed to the pasteurisation of milk on the grounds that it increases costs and reduces the food value, the majority now realise the need for a clean product and are striving to attain this end.

It may be said emphatically that pasteurisation is imperative for all milk produced by non-tested herds if the spread of disease is to be avoided. Milk, being a complete food, is highly encouraging to bacteriological existence and reproduction, and while relatively few cows have tuberculosis in the udder or other parts which would convey the disease directly to milk, the milk of numerous cows is usually bulked before sale and consequently, the milk from one infected cow can, in this way, pass on the danger to many people. Similarly, although cows suffering from tuberculosis of the lungs do not produce contaminated milk, infected droplets from the breath may easily introduce the bacillus into milk after it has been drawn.

Milk may also pick up disease organisms from workers. Unless the staff is supervised regularly and withdrawn if suffering even from the slight throat troubles or other infections, there is a risk. *The safest milk of all is that which is pasteurised and bottled after it has last been handled.*

Pasteurisation has the further advantage of allowing milk to be kept sweet for longer periods and is an asset when milk has to be transported long distances to the consuming centres. It has taken much of the unpleasant early rising out of farming.

The principal method of pasteurisation is to heat the milk to a temperature of not less than 162° F. for 15 seconds. This is known as the High Temperature Short Time (H.T.S.T.) method. The older, or Holding method, by which milk is heated to 145° F. for 30 minutes, is

being superseded as fast as the new equipment can be installed in dairies.

The loss of nutrients caused by heat-treating the milk is too small to make the feeding of contaminated milk, especially to infants, worth the risk. When large groups of children were tested for reaction to raw and heat treated milk, no differences in results were found, though none of the tests were absolutely conclusive owing to other conditions not being standardised. It is interesting to note that girls, especially of the older school ages, benefited most from increased milk allowances.

Further reading—*Farm Animals* by Dr. John Hammond, Edward Arnold & Co.

CHAPTER II

THE MILK COW AND THE BREEDS

The Breeds compared for Milk Production

The first general factor influencing the yield and quality of milk obtained from a herd is the breed of cow stocked. The table on page 14 shows the breeds in use in Britain and the average yields and butter fat content as compiled by the Milk Records Association. Those breeds marked * are of local importance only and are maintained, in relatively small numbers, either because they are hardy and thrive in exposed positions, as in the case of the Welsh Black, or because they are particularly suited to certain circumstances or trades.

If the six important breeds are considered it will be found that, generally, the heavier breeds produce the highest yields, while the order of quality, as represented by butter fat, is approximately the reverse.

The yields shown are from "Recorded" herds, in which production is measured regularly by officers of the National Milk Records Association. Unfortunately, recorded herds form only a small, though growing, percentage of our cow population. The tendency is for only the better herds to be recorded, these being owned by the more careful farmers who consider the trouble of recording to be worth while. No available figures cover the over-all yields of each breed, but the figures for the whole country and covering all breeds, show an average annual yield of rather less than 500 gallons per cow. Many cows retaining a place in herds produce no more than 300 gallons.

When it is pointed out that the majority of British cows are of the heavier yielding breeds—Friesian, Shorthorns and Ayrshires—it becomes obvious that the 500

gallon average is much below that of recorded herds. In turn, the recorded yields are considerably under what may be termed the optimum yield for each breed. The optimum yields may be taken as 25%—30% above the averages shown and are attainable under normal commercial conditions.

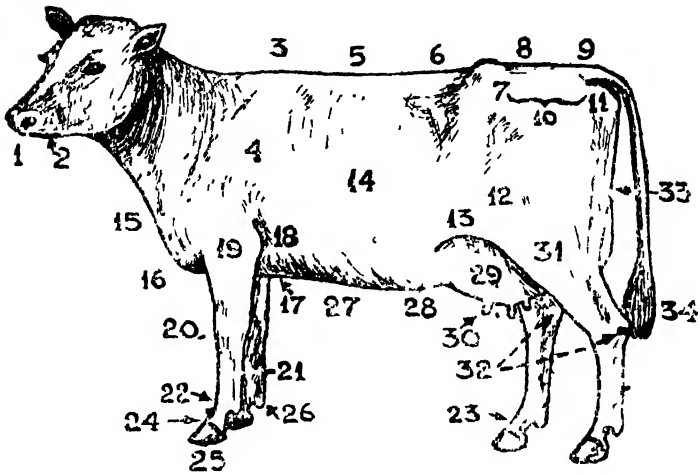
Breed.	Liveweight	Average Milk Yield		Butter Fat	Total. Butter Fat
		Cows	Heifers		
	lbs.	Gallons.	Gallons.	%	lbs.
South Devon.	1,450	621	491	4.23	263
Lincoln Red	1,300	720	557	3.62	261
British Friesian.	1,250	855	726	3.45	295
Dairy Shorthorn	1,250	693	558	3.63	252
* Welsh Black.	1,150	529	445	4.09	216
Red Poll.	1,100	723	579	3.64	263
Ayrshire.	1,000	755	655	3.83	289
Guernsey.	950	707	614	4.56	322
* Kerry.	850	670	593	3.97	266
Jersey.	800	671	556	5.03	338
* Dexter.	650	486	421	4.30	201

From National Milk Records Association Report
These figures are for lactation of 305 days.
* Of Local Importance only.

Of the breeds mentioned, the Friesian, Ayrshire, Guernsey, Jersey and Kerry are considered to be dairy types—their only worth being as milk producers, and males not wanted for breeding are slaughtered almost at birth. The remaining breeds are termed dual-purpose, producing economical milk yields, while males not wanted for breeding, cast heifers and cows not in milk can be fattened to make satisfactory beef carcases. Although the Friesian has been included as dairy type, the tendency has recently been to develop the beef side without sacrificing the deep milking qualities.

The Dairy Cow

Certain "fashions" have been set for the appearance of dairy cows, and while many of these bear little relationship to milk production, there are some features which appear to be desirable. Thus, as the cow must convert the main portion of her food to milk, retaining only the minimum for maintenance and health, her frame must be



KEY TO POINTS OF THE COW

1	Muzzle	18	Elbow
2	Chin	19	Forearm
3	Withers	20	Knee
4	Shoulder	21	Shin
5	Back	22	Pastern Joint
6	Loin	23	Pastern
7	Hook	24	Coronet
8	Rump	25	Hoof
9	Tail Head	26	Dewclaws
10	Plate	27	Milk Wells
11	Pin	28	Milk Vein
12	Stifle	29	Udder
13	Flank	30	Teat
14	Barrel	31	Thigh
15	Dewlap	32	Hock
16	Brisket	33	Escutcheon
17	Chest	34	Switch

of a type for which heavy feeding is not required. She should show no tendency for laying on flesh, the bones should be light and fine, skin thin and soft and the general air should be one of refinement.

The barrel should be round and deep to allow ample room for a large digestive tract, and a well developed mammary system is an obvious necessity. As she must calve annually with the minimum of trouble she must, to facilitate parturition, have long, wide and loosely knit hindquarters. The calves must be as good as she is, so that the cow must come of a family which, for some generations, has shown good milking qualities, economic conversion of food to milk, and longevity.

In general outline, the "approved" type is level of the back, straight from the pins to the thighs and the underside should rise slightly as it runs forward from the udder. Thus, the suggestion of a triangle, or wedge is formed. Another wedge is formed as the back narrows from the hooks until it becomes almost a point at the withers The shoulders should be fine and sloping as they rise to the withers and so form the third "dairy wedge".

The legs should be fine and straight, while the hocks should be broad and carried wide apart when moving. Viewed from behind, the hocks must not turn inwards as, for example, is seen in many horses. In combination with flat and lean thighs, ample space must be left for the udder.

A fair chest width is necessary for lung and heart room and, as in man, point in a general way to a good constitution. The dewlap and brisket must be light as bulk in these parts is associated with beefing tendencies.

The head should be long and refined with a feminine appearance, the eyes being alert but placid. Good length from the forehead to the muzzle indicates light fleshing qualities, and a strong lower jaw is essential in a grass cropping animal. A wide muzzle is associated with docile temperament. A fine neck with slightly wrinkled skin is wanted and it should run neatly into the shoulder. Ears and tail should be thin, the skin loose and horns, if present, finely tapering and waxen in appearance. A smooth, shining coat, or, in farming parlance, a "good bloom", portrays health.

The mammary system is extremely important, though

its worth is difficult to assess. The udder should be long, wide and level along the bottom or "sole" and held high up between the legs The four teats must obviously be conveniently placed for milking and large enough to provide comfortable hand hold, but it is not necessary to make a fetish of their size and shape as has been mistakenly done in the past. Pendulous, or loose hanging udders are to be avoided as they are liable to damage if the animal scrambles through hedges. In extreme cases, the cow may injure her teats by standing on them when rising or, when lying together in stalls, her neighbour may do so.

Although the udder must be of good size if it is to produce and store large quantities of milk, size alone is no reliable indication of yield—bulk may be composed mainly of unproductive fat. Unfortunately, cows with such udders still win prizes, and it is distressing that many farmers judge a cow by appearance and prodding it with a stick. Without a cow's milk record, the only way to judge an udder is by feel. One built up largely of fat changes very little after milking and remains hard, while a highly productive udder is reduced in size and is soft when empty. The skin is then loose and elastic and can be gathered in the fingers.

Blood is supplied to the udder by two arteries and leaves by several veins. Of these, the "milk veins" which run along the belly and enter the body at the milk wells, are the only ones visible. If these are prominent, it is assumed that the udder is well supplied with blood. Their size, however, can be taken only as a general indication of efficiency.

The Dairy Bull

Except for the appearance of masculine qualities, dairy bulls should follow much the same description. The general build is stronger and the head shorter with more breadth. The horns are, in most breeds, thicker and straighter and the appearance and demeanour should be masculine and masterful. A belligerent nature is a nuisance and a danger but it is difficult to dissociate this from mature bulls, especially those of the lighter, horned breeds.

Breed Standards of Excellence

The foregoing are, broadly, the points demanded by Breed Societies, who govern the policy and protect the interests of their respective breeds. They are incorporated in the Breed Standards of Excellence and provide the guides on which show judges base their findings. The wording of the Standards is essentially rather vague and judges and breeders place their own interpretations on them. Thus, as current opinion veers between the extremes of latitude given, breed fashions change.

The Standards serve in preserving some uniformity in type, but are of little value in judging the productive worth of cows and still less in assessing the capacity for passing on milk yield characteristics. As was seen when discussing milk secretion, even the udder size is no guide to capacity and indeed, many cows which are handsome and quite impeccable according to Breed Standards, are poor milk producers.

The Dual-Purpose Cow

The dual-purpose cow, besides giving an economic milk yield, must fatten successfully when dry and produce bull calves suitable for beef production. The Dairy Shorthorn is fairly typical of the dual-purpose breeds and may be described as a heavy dairy type animal. The dairy wedges are not so pronounced, more flesh is carried and the head is shorter. The Red Poll, on the other hand, is more square in conformation and resembles the refined beef-type Aberdeen-Angus, but having superior mammary development. All dual-purpose cattle have shorter legs than dairy types, with the thighs well fleshed almost down to the hocks. The back is broader. The tail head should be well placed to permit filling in across the rump. Bulls should have no hollows behind the shoulders and the tendency should be towards fleshy ribs and hindquarters, which provide the expensive beef cuts.

The Breed Standards for dual-purpose cattle must endeavour to emphasise the good points for milk and beef, so that neither is sacrificed to the other.

For greater success in the beef market, dual-purpose

cattle should not be large. Public taste has, because of the smaller families now ruling, deserted the large carcases popular with earlier generations in favour of one providing smaller joints. Medium-sized breeds, of early maturing character and producing a fat steer of 10 cwt. are best suited to meet the higher priced trades, though carcases of 13 cwt. are still sought after in industrial areas. While beef is still in short supply, large animals suffer no handicap.

The Dairy Breeds

British Friesian. The Friesian, British by adoption from Holland, is the largest of the dairy cows and the heaviest milk producer of all. Many records above 3,000 gallons are held and under normal commercial conditions, herd averages of 1,000 gallons and over are common.

It is frequently stated that Friesians produce milk of low fat content, but the charge is now largely out of date, so persistent have the breeders efforts been to improve this quality. The critics should remember that, on average, Friesians produce more fat in a lactation than all other cows except Jerseys and Guernseys. The fat globules are smallest of all the breeds.

Judged by close dairy standards, the conformation is merely fair, but high yielding Friesians have proved that good looks are not vital. The milk veins and wells are strongly marked, and the udder well developed. In some strains, they become pendulous with age.

Friesians are reputed to be reliable breeders for milk yield, which means that, when high producing strains are mated, it is likely that the progeny will be similarly endowed. If the character for milk could be fixed in this way for all cattle, much of the worry would be taken out of farming.

Up to a point, Friesians are hardy but require good feeding. They are found mostly in fertile areas.

Breed colours are black and white in clearly defined patches, but occasional red and red and white calves make an unpopular appearance. A white splash on the face is desirable and the horns are small and turn inwards.

Emphasis has recently been put on the beef qualities of

the breed, and arable farmers are castrating bull calves and feeding them successfully as fat stock. For mature beef, the tendency is for the carcase to be rather large with a high proportion of waste, due mainly to big bones Friesian calves are large and fat at birth and feed readily for veal. The "parent" breed in Holland is dual-purpose.

Under the name of Holstein, the breed is widely used in America

Ayrshire. This breed was developed by John Dunlop, of Dunlop, North Ayrshire, Scotland. The county is still the breed's stronghold, although recent and rapid develop ment has distributed Ayrshires throughout Britain and the temperate zones of the world The cows are medium-sized and a model of the theoretically perfect dairy type. The wedges are pronounced, the bone light and flesh sparse, while the udder, long, level and appearing as part of the frame rather than a suspended bag, is generally regarded as the pattern for all breeds.

Good Ayrshires are economical milkers Yields of 1,000 gallons and over are common. Butter fat averages are satisfactory. The fat globules are small and the milk is therefore easily digested

Ayrshires are the most adaptable and generally useful of the dairy cows. They have more or less developed into two types, those on sheltered, fertile situations being heavier than the usual run On the upland farms of Scotland the animals are kept small and it is considered that the lower food requirements offset the resultant smaller yields

Surplus bull calves are slaughtered when a few days old as they cannot be successfully fattened, though, on rare occasions, this has been done

The popular colours are brown with white markings and white with brown markings Great variety occurs in the proportion and pattern of these colours, coats ranging between almost solid brown to solid white Black, and black and white animals are not unknown, but are not popular

The horns are a distinctive feature, rising in a sweeping, graceful curve. But they are a serious drawback when large herds of cows are kept and have caused many accidents to attendants, especially while feeding stock tied

in stalls. Breeders have attempted to reach agreement whereby all calves are de-horned, but, so far, the only step taken is that de-horned stock will not be penalised in the show ring. Attempts are being made to breed hornless Ayrshires.

A great feature of the breed is the high number of tubercle-free herds, their native county and its neighbours, where Ayrshires preponderate, being almost clear of the disease. It is also claimed that there are more T.T. Ayrshire herds in Britain than of any other breed, and this has popularised them greatly for the foundation of new T.T. herds. Unfortunately, this does not appear to be due to constitutional vigour on the part of the cow, but to the admirable policy of the principal breeders and Herd Society. They must also be credited with much of the early work in milk recording and have, as a body, done much to advance the breed and, incidentally, the industry.

Guernsey. A Channel Islands breed. Although the Islanders export cattle, no live animals are imported, and in this way, the blood of native stocks is kept pure.

Smaller than Ayrshires, the cows are of fair dairy conformation. The quality of Guernsey milk is excellent, containing 4.5% to 5% butter fat, and is deeper in colour than any other milk. Owners of Friesians and Ayrshires retailing bottled milk frequently keep a few Guernseys and improve the colour and quality of their product by mixing the milk. It is thus more acceptable to housewives.

In addition to the high content, the fat globules are large and cream readily. The milk is, in consequence, of great value in butter making, but for the liquid trade, it has disadvantages. It is not easily digested by children and the large fat globules tend to associate or collect when shaken in transport. For general use, milk containing fat in finer dispersal is more suitable.

The breed is mainly confined to the milder districts of Southern England, though cows are kept successfully in Scotland.

The horns are small and coat colour appears in different shades of fawn with, frequently, white markings. Guernseys do not fatten and the yellow fat is disliked by the public.

Kerry. Kerry Cattle are of Irish descent and are not numerous. The colour is black and the general conformation good. The horns are prominent like those of the Ayrshire. The milk yield is good in relation to the small size and the conditions under which herds are kept The breed is hardy and is mostly outwintered.

Jersey. Like Guernseys, Jerseys are from the Channel Islands and are similarly protected by the non-admittance of live cattle to the islands. Jerseys are very lightly fleshed, the conformation is refined and the horns are small and curved forward. Fawn is the most usual colour, though some animals are silver grey and others almost black.

Milk is similar in character to Guernsey milk but is even richer and normally contains 5% butter fat. The colour is not quite so deep.

The breed does best in Southern England, though herds are run with success in other parts of the country. They are of no value for beef.

Dual Purpose Breeds

South Devon. This is the largest and heaviest breed in use in Britain. The shoulder is rather heavy and the build coarse, resulting from development during the period when the animals were used for work. The coat is curly, and red the most popular colour. Horns are prominent and curve upward.

Occasional animals have yielded 1,000 gallons, but the recorded average is 620 gallons, which is not efficient production from so large an animal. The milk is rich in colour with over 4% butter fat, and is used in the Devonshire cream trade. The breed, as milkers, is confined to Devon and Cornwall.

Steer carcases (castrated males) are in demand in the industrial areas of the Midlands of England, where they are fattened on grass.

Dairy Shorthorn. Numerically, the Shorthorn leads all other breeds in England and Ireland but is almost unknown in Scotland. The cows are large and heavy and in view of this, a recorded average below 700 gallons cannot be regarded as satisfactory. Butter fat is ordinarily 3.6%. Evidence suggests that the breed is losing ground

and has probably suffered through wide use in indifferent hands. There are, however, many fine Shorthorn herds, averages in excess of 1,000 gallons being quite common, but the fact that the breed is generally of better quality in Ireland is a reflection on English breeders.

The Shorthorn is typically dual-purpose. The head is short, the body well fleshed and, in good specimens, the udder is sound. Old cows fatten well, but steers are best when killed before they are two years old. Those over that age are too large in the joints for normal trade but in times of scarcity, of course, size is an asset.

The breed was widely used in the now almost extinct town dairies of the "milk and feed" type, and suffered in consequence. In these dairies, the one object was to get milk, cows being mated merely to get them in calf with little or no interest taken in the choice of bulls. Thus a great many undesirable calves were dispersed throughout the country.

Shorthorns are hardy and suited to the full range of British farming conditions. The colours are red, white, and roan, the last being the most popular. It is said that many farmers will pay more for a roan bull, but roans will not breed true and will produce offspring in any of the recognised colours.

Lincoln Red Shorthorn. A local variation of the Dairy Shorthorn but larger in size and of uniform red colour. The breed is practically unknown outside of Lincolnshire. The animals are large boned and steers do not fatten well for the younger classes, the extra food being used for growth.

Blue Albion. Originated from the crossing of White Shorthorns and black cattle, probably Welsh Blacks. Only blue roan calves are accepted for the Herd Books, and as roans do not breed true but throw self-coloured black or white calves as well as roans, many offspring of registered parents are ineligible for pedigree status. A further anomaly is that, when "outcast" blacks and whites are mated, they are just as likely to produce roan calves as the roans themselves. Because of these difficulties, the breed is unlikely to progress.

Red Poll. Red Polls originated by crossing the old Norfolk Horned breed and the Polled Suffolk Dun, the former being a small, hardy and early maturing beef

breed, while the Suffolk Dun was noted for high yields and rich milk. Some writers maintain that the Norfolk was also polled, or hornless. Subsequent breeding and development have fully maintained the original intention of combining milk and beef and to-day, Red Polls are the outstanding example of dual-purpose cattle.

Steers mature rapidly for beef, and carcases in all beef classes equal those of the specially developed beef breeds.

Many winners of fat stock events at Smithfield have been out of cows yielding 1,000 gallons. Red Polls pioneered the baby beef trade—i.e., steers sold fat at 15 months.

The cows are medium-sized and, on recorded averages, are narrowly beaten by Ayrshires for second place in the production lists for all breeds.

The breed colour is red, the deeper shades being preferred. The absence of horns, combined with the docile temperament, is of great value when cows are grouped. The general conformation is similar to the best beef types and while udders were at one time pendulous, this fault is being bred out.

Red Polls are extremely hardy, dairy herds being kept in part covered courts on exposed positions. The breed is famous for the number of old cows in full production and is the longest lived of all.

Bulls are frequently used in crossing. They pass on the hornless character when mated to horned cows, though in some cases, abortive horns, which do not develop, arise. Increasing appreciation of the breed abroad is shown by the wide export trade, which has developed. The deep red colour enables the animals to withstand hot sunshine.

Welsh Black. This breed is only valuable on the exposed and poor pastures of Wales. The yield is low (530 gallons) and the steers mature slowly, but both these points are satisfactory when related to the feeding usually available to them. The conformation is beef type with a good flesh cover. The coat is black, and the horns white with black tips.

Dexter. The smallest of the breeds, the cows being little larger than Shetland Ponies. They are often mounted on platforms like goats for convenience in milking. The breed is native to Ireland and related to the Kerry. The body is square, legs short and the head dis

proportionately large. Coat colour is black or red and horns cocked like Ayrshires. Dexters are exceedingly hardy and mostly outwintered. Under these conditions, production is good.

A great disadvantage is the regularity with which "bulldog" or monster calves are born and, in all, three types of calf are produced in definite proportions. These are:—

Dexter Type.	Short Legs.	50%
Kerry „	Long Legs.	25%
Bulldog „		25%

Bulldog calves are aborted at seven months and are so malformed that they are either stillborn or die shortly after birth.

Breed Societies

A Breed or Herd Book Society guards the interests of each of the breeds. These Societies are highly progressive bodies, run by an elected committee of breeders, and have done much to improve cattle stocks. Their sphere has enlarged in recent years with the addition of performance records to the pedigree lists. Though relatively few breeders are members of Societies, membership is necessary if pedigree stock is to be the aim. The appropriate Society alone can effect registration.

The Breed Societies have special classes for animals reaching a high level in yield and butter fat. For bulls which have sired a number (usually six or ten) of daughters attaining the stated yields, there is a Register of Merit, while cows reaching a required standard are included in an Advance Register. Animals qualifying in this way have the letters R.M. or A.R. alongside their name. The qualifying yields for these registers vary with the breeds.

Further reading. *The Cattle of Britain*—Frank H. Garner, Longmans Green & Co., Ltd. *The Milch Cow in England*—E. R. Cochrane, Faber & Faber, Ltd.

CHAPTER III

CHOICE OF BREED

FAMILIES and individuals within a breed differ greatly. The points made in this chapter are of a general nature and should be related to the individuals finally chosen (see Chapter V). It is impossible to indicate the "best" breed (an attempt to do so would be dangerous as well as futile!) but an effort is made in the following notes to put the available information before the reader.

DUAL PURPOSE AND DAIRY BREEDS

Immediately before the second World War, the cost of imported beef equalled almost a third of the total value of home produced agricultural products. At that time, home beef production was unprofitable, and arable farmers buying Irish and home steers for fattening were satisfied if they sold them fat at prices which covered the feeding costs, leaving only the dung as profit.

World conditions have changed since then. There is no longer an abundance of beef awaiting shipment to us, nor can we afford to buy such small surplus as may exist. Home production has become a necessity, and to encourage this, prices for fat stock have been made remunerative. But the dominant place now held by dairying in our livestock farming, coupled with an intensive Agricultural system which precludes large scale beef ranching, has left us in the position that the demand for stores for feeding to beef cannot be met unless they come principally from dairy cows. Subsidies for beef type calves have been introduced to focus the dairy farmers' attention on this type of animal.

Adherents to the dairy breeds hold that efforts to produce milk and beef from the same herd lead to inefficient

production of both. The experience of dual-purpose breeders proves this assertion false. Great progress has been made in fixing the combination of characters and the 800—1,000 gallon cow, producing a good steer calf (at one time considered to be the ideal to aim at) is commonplace.

Dual purpose breeding is the policy in Northern Ireland and Eire, whose governments actively discourage dairy types by offering subsidies only to farmers who use Shorthorn bulls. Informed agricultural opinion in England, always leaning towards dual-purpose, now believes them to be an economic necessity.

In Scotland, where probably 90% of milk comes from dairy herds, a new interest in dual-purpose types is evident. Apart from the interest in beef stimulated by better prices it is realised that the high wastage in dairy breeds, which amounts to 50% of the animals born, is anomalous in a country rationed for beef and likely to continue so for an indefinite period.

For dairy cattle it is contended that high yield to low food consumption is the most profitable combination. As may be seen from the table at the end of this chapter, dairy breeds are the more efficient producers of milk per unit of liveweight and thus are claimed as best for the small, intensive farm where bulky foods are in short supply. This was probably true when imported foods could be bought freely.

It is also very doubtful if such refined and specialised types, lacking a protective covering of flesh, are suited to anything but the best conditions of climate and feeding.

It is often assumed that the dairy cow requires less food for the maintenance of her body than dual-purpose cattle of similar liveweight. This is wrong and, indeed, the reverse may be the case, as the dairy breeds, especially the smaller, are more temperamental and restless and use a proportion of their food for extra activity.

Owners of intensive dairy farms hold that they cannot spare the milk and labour necessary for the rearing of steer calves, and that it pays better to get rid of them at birth. Here one sees, reluctantly, the need for control. The present exceptionally high demand for milk will recede, leaving us with some surplus, and the suggestion is offered that, when these times come, marginal and

remote farms at present producing milk uneconomically, should be nominated as rearing farms.

To these farms, surplus steer calves from intensive areas would be sent for rearing by nurse cows, as is done in many cases at present. (See Chapters VI and VIII) Marginal farms are also very suitable for the rearing of the calves through the store period until they are ready for fattening, when they would be returned to arable and rich grazing areas for finishing. In this way, many thousands of animals, at present lost as food units, could be made available annually, providing, at the same time, satisfactory returns to all concerned in their handling

This system of running dual-purpose herds, together with the better development of such areas as the Highlands of Scotland so that they could support larger populations of the hardy beef breeds like the Galloway and Highlander, either pure or crossed with the Scotch Shorthorn, would greatly alleviate the shortage of beef. It would also bring about a better balance between milk and beef types, which at present threatens to be too heavily weighted towards milk.

Points for Consideration in Choosing a Breed

In choosing a breed, the following points must be considered:—

Environment The breed chosen must be able to thrive on the climatic conditions of the farm and on the level of nutrition available. The latter, while partly dependent on the climate, is also affected by the degree of soil fertility which can be attained economically.

Although several breeds may fit the conditions, many farmers choose the locally favoured one without further thought. This policy has advantages, particularly in the buying and selling of stock, but that it is not necessarily the best is demonstrated by the number of established farmers who are making changes. Friesians, Red Polls and Ayrshires are continually invading new ground. The choice lies roughly between (*a*) on the poorer farms, a breed sufficiently hardy to live and produce economically under the conditions and (*b*) on rich land, one able to take full advantage of abundant feeding. Thus, it would

be disastrous to install a herd of Jerseys on the wettest and bleakest parts of Cumberland, while Dexters could not give sufficient return on the rich pastures of south-west Scotland. A herd of potentially deep milking Friesians sharing an unfertile farm with Ayrshires would probably fall below the latters' production figure.

Ayrshires, Red Polls and Shorthorns are able to withstand the full range of climatic and feeding conditions found in Britain, while Friesians require the abundant feeding possible only on better class farms. Channel Island breeds do best in mildest districts.

Milk Yield in Relation to Liveweight

Several factors govern the value of the yield, among them being its ratio to liveweight. The heavier a cow is, the more food she requires to maintain her frame. Obviously, *other things being equal,* a cow of 1,000 lbs. liveweight producing 750 gallons will be more profitable than a 1,300 lb. cow yielding the same quantity. It must be remembered, of course, that the additional food for maintenance is made up of hay, straw and roots and that the extra cost of these may be more than covered by the better price received from the butchers for a well-fleshed cow when her milking days are over.

The larger cows can deal with more of these bulky foods and whereas a 1,250 lb. cow producing 3 gallons of milk daily may be fed on a ration of hay, green crops and roots, a cow of 1,000 lbs. would require expensive concentrate feeding to cover part of her needs. (See Chapter X.)

Length of Productive Life. The short milking life of cows is the greatest deterrent to profit. The British average of 3.1 years means that one third of our milking cows are lost annually through disease. Instead of having heifers for sale, the average farmer requires every one he can rear to keep his herd going. Many farmers have to buy heifers and even cows in milk to maintain their herds.

To say that a cow gives 800 gallons in a lactation is of little value if it is not known for how many lactations she may produce. It is the lifetime yield that matters. Before she milks, a cow is reared through almost three unpro-

ductive years and in addition to her keep while milking, the cost of rearing must be charged against her. The longer she lives, the lower is the proportion of rearing charges to be set against each gallon produced.

Heifers produce only about two-thirds of the mature cow's yield, maximum production being in the sixth and seventh lactations. Few cows reach this stage and the present replacement rate means that one third of the majority of herds are heifers, one third second calvers and the remainder in their third and last lactation. Few herds therefore, attain full potential output.

Because this aspect is vital, the advantages of longer herd life are summarised thus:—

1. Fewer replacements, permitting the sale of a proportion of the heifers raised.
2. Rearing charges spread over a longer period, giving lower cost per gallon of milk produced.
3. Fewer young animals and more mature cows in the herd, resulting in better herd yields.
4. Greater opportunity to cull calves from disappointing cows.
5. More calves from good cows.

In the Bureau of Records Report for the period October, 1946/September, 1947, the length of life of cows of the six main breeds is given (age in number of lactation). The following is a summary of the information tabulated:—

	Ayrshire	Friesian	Guernsey	Jersey	Red Poll	Shorthorn	6 main breeds average
Average number of lactations ..	2.8	3.1	3.3	3.2	3.5	3.2	3.1
% of cows with 4 or more lactations	29.2	32.8	35.6	36.1	41.7	39.1	35.9
% of cows with 7 or more lactations	4.5	5.7	8.4	8.8	13.5	8.1	7.2

The main reasons for rapid wastages are sterility, disease and failure to produce sufficient milk.

Value of Non Milking Animals

If a profitable sale can be found in the store or fat stock markets for non-milking animals, the herd adds to its value by providing a secondary income. Dual-purpose breeds score in this respect.

Summing Up

After a long investigation, the writer concludes that, in light of our prospects, Red Polls and Friesians (when considered as dual-purpose) are the most useful breeds we have. However, a comparison of breed performances is shown for the reader's consideration in the following table. Figures for yields, butter fat and length of life are taken from official sources and apply only to recorded herds. Liveweights shown are those generally accepted for the various breeds

The information contained in the other columns is, by necessity, the author's estimate While it is hoped that the findings will be agreed to by most authorities, they must be taken only as general guide

TABLE OF BREED COMPARISON

BREED	Liveweight	Milk Yield (cows)	Butter Fat	Milk Yield per 100 lb Liveweight	Herd Life	Life-time Production*	Suitable Climate British Conditions	Plane of Feeding Required	Value of Non-breeding males		
									Veal	Baby Beef	Mature Beef
	lbs	Gals	%	Gal	Lactations	Gals					
Friesian	1,250	800	3.45	68	3.1	2,521	Fair	High	Good	None	Fair
Shorthorn	1,050	693	3.63	55	3.2	2,082	Any	Average	Good	Fair	Fair
Ayrshire	1,000	755	3.83	75	2.8	2,014	Any	Average	Potted Veal	None	None
Red Poll	1,100	723	3.64	66	3.5	2,387	Any	Average	Good	Good	Good
Guernsey	1,050	707	4.56	70	3.3	2,240	Mild	Good	Potted Veal	None	None
Jersey	900	681	5.03	84	3.2	2,032	Mild	Good	Potted Veal	None	None

* *Based on 1 heifer lactation, the remainder being cow lactations.*

CHAPTER IV

THE BREEDING AND IMPROVEMENT OF CATTLE

THE low average yield of dairy cows and the brief period of their milking lives reveal lack of understanding, or careless disregard, of breeding technique. Many farmers are exempt from these charges and the superior performance of their herds emphasises the general inefficiency and also shows the high standards which can be attained under British conditions.

Formerly, successful breeders depended entirely on their ability and powers of observation. Recent advances in the study of genetics and performance recording have placed the tools for stock improvement in the hands of every farmer interested in his animals and in his own prosperity.

Genetics is a young science and cannot yet, if it ever will, offer positive guidance in all breeding problems. Obscure points remain for elucidation, and it is mainly in simple characteristics that the type of progeny which will be produced by two animals of known quality and performance can, with some certainty, be foretold. Nevertheless, enough work has been done to minimise chance and to lay the foundations of a sound breeding policy. It is therefore profitable to examine briefly the workings of inheritance and all available aids before discussing the selection of individual animals.

INHERITANCE

Each animal has a double set of characters, some of which it inherited from its father's side and some from its mother's side. These character factors are associated with a substance called chromatin which is contained within the nuclei of the cells.

The body is made up of millions of cells, each composed of a nucleus in a field of cytoplasm. They are the living tissue of the body and vary in shape from spherical to roughly star-shaped formations. The nuclei are mainly spherical, though some are elongated.

The cells are separated from each other by a by-product of their own activity. This material acts as a framework In "soft" areas, such as the kidneys, little material surrounds the cells, but in bones it is hard and abundant and the cells are widely spaced. The cells are fed by nutrients carried in the blood.

When isolated, cells are like clear jelly and are so flaccid that they cannot hold their original shape.

Each new cell added to the body results from the simple division into two parts of a single cell, the new cells being called daughter cells The process starts with the dividing of the fertilised egg from which the individual grows and is rapid in the embryo and during growth It continues, in modified degree, throughout adult life.

When a cell divides, a complicated process occurs within the nucleus. The character factors received from each of the animal's parents are concentrated there on thread-like bodies called chromosomes In cattle, each nucleus contains 30 pairs of chromosomes (30 from each parent) and this number is constant for every animal of the species On the chromosomes, the genes, each of which is responsible for a character, are situated. Thus, there are genes which control coat colour, the thickness to which the tail will grow, the ultimate size of the animal and so on, covering every factor in its make up The animal has, of course, two of each.

The genes are too small to be seen or counted, but it is known that there are large numbers on each chromosome. Each gene has a definite place on its chromosome and does not appear on the others.

Although the genes for each character are present in every cell, they can only express themselves when the environment is suitable. A gene for blue eye colour remains dormant in a nerve cell of the tail, but is "organised" in the eye cells.

As the cell prepares to divide, the nuclear wall breaks down. The chromosome threads thicken and split lengthwise, one half of each going to opposite ends of the cell.

RED POLL BULL · Kirton Red Fox 3rd. Official record of daughters : 36 daughters averaged 7,679 lb., 3·88 per cent butter fat, with first calf.

RED POLL COW : Honest Sonia. This demonstrates a good dual-purpose cow. She has bred five calves in 52 months and her lactation yields are : 1st calf 805 gallons, 2nd 940 gallons, 3rd 1,380 gallons, 4th 1,261 gallons, present lactation 1,047 gallons in 168 days. Her points are demonstrated in the following photographs, published in a brochure by the Red Poll Society, the captions given here by kind permission.

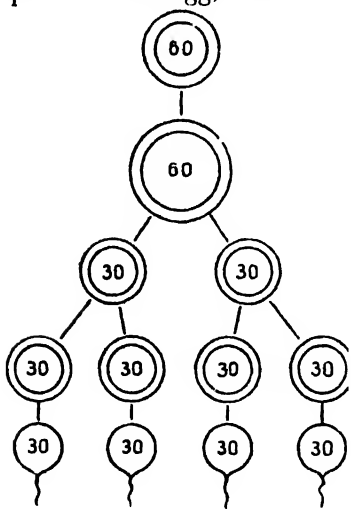
Thus, when the cell finally breaks in the middle and becomes two, each new cell has a full set of chromosomes contained within its nucleus.

This process is known as mitosis.

The manner in which animals pass their characters on to their offspring involves a further division which ensures that, instead of receiving a double dose of chromosomes (as would happen if two ordinary cells united) the new animal will have only its proper quota of 30 paternal and 30 maternal chromosomes. This process is known as reduction division or meiosis.

From puberty onwards, sex, or reproductive cells, mature in the testes of the male and ovaries of the female and, by division in two stages, each sex cell gives rise to four sperms in the male and one egg and three polar bodies in the female. These polar bodies have no known function and rapidly disappear.

During the reduction division, the chromosomes are "shuffled" and *one of each pair* goes to opposite ends of the cell. The cell then divides to form, eventually, the sperms or the egg, known collectively as gametes (See diagrammatic illustration of the process as it occurs in the male)



Potential sex cell or spermatogonium which grows to

|

Primary spermatocyte, which divides by meiosis to form

Secondary spermatocytes, which divide by mitosis to form

|

Spermatids. These develop a body and tail and become

|

Spermatozoa or "sperms".

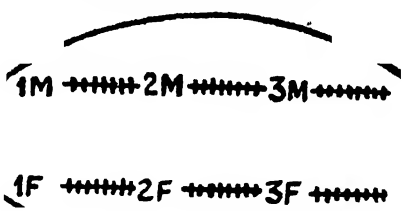
The inner circle in each case represents the nucleus and the figures show the number of chromosomes contained.

(The maturation of the female sex cell is essentially the same, except that three of the four final bodies are cast off.) In this way, each gamete has only 30 chromosomes, so that, when an egg is fertilised by a sperm, it gives rise to a new animal having the correct balance of 60 chromosomes or 30 pairs.

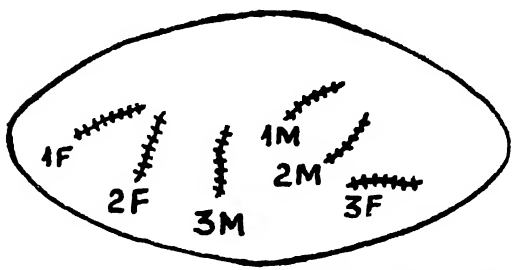
In the reduction division, the order in which the chromosomes assort is not controlled, but each gamete receives one of each pair. Thus, if the chromosomes were numbered 1M to 30M for the paternal set and 1F to 30F for the maternal set, each gamete would have one of each number but could have a majority from either parent. One sperm, for example, may have its assortment made up in the following order: —

1F 2F 3M 4F 5M 6F etc.

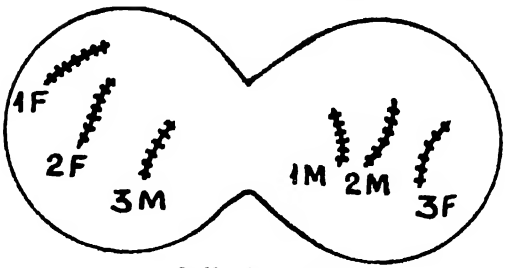
The following sketch illustrates the process, using, for simplicity, only three of the chromosome pairs —



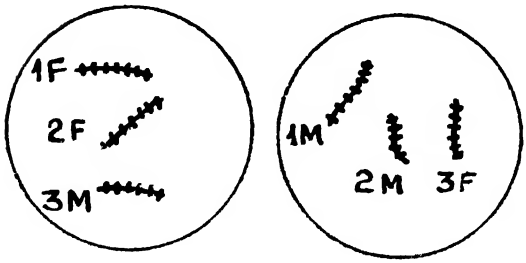
Chromosomes of primary spermatocyte paired off before reduction division



Chromosomes moving to either end of cell



Cell dividing.

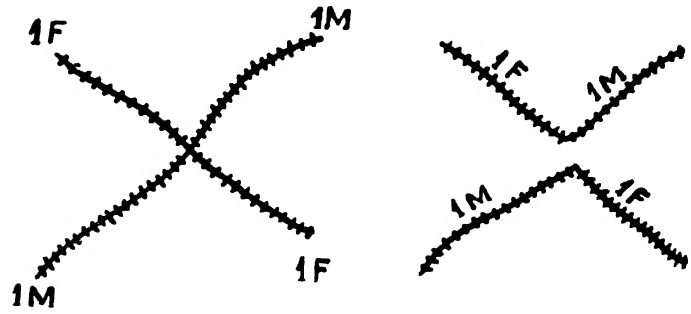


Secondar spermatocytes formed from primary spermatocyte The four sperms arise from the final division by mitosis, retaining the chromosome arrangements of the secondary spermatocytes

At mating the bull discharges some 5,000 million sperms, but only one egg is normally discharged from the cow's ovary The sperms propel themselves along the moist tissues of the female genital tract to meet the egg Only one can effect fertilisation as, when pierced, the egg immediately hardens and the remaining sperms die

The variety of chromosome assortments which can occur in an egg or *any one* sperm have been demonstrated and is an indication of the part played by chance in the apportionment of the characters of the calf In Pure Lines, where no variety exists in the chromosomes of the two parents, this would be of no importance, but as Pure Lines are impossible in animals, considerable differences appear in successive offspring of the same parents Brothers and sisters are never exactly alike

Further variations may occur through the crossing and re-crossing of chromosomes during reduction division. When chromosomes cross, they may be nipped off at the junction and thus a single chromosome may comprise sections and, of course, genes from each parent. The following sketch illustrates this:—



The Expression of Genes

In the mating of two pure-bred Red Polls, the chromosomes of the egg and sperm on which the genes for coat colour are situated, come together in the fertilised egg and the colour genes meet As both animals are pure or homozygous for this character, the calf's coat would be red If, however, a black animal were mated to a red one, the gene for coat colour contributed by the black animal would overpower the colour gene from the red one and the calf would have a black coat. Thus, black is *dominant* to red, and red *recessive* to black

The gene for white coat behaves inconsistently. In combination with black it has equal power, and the mating of a black animal to a white one produces a calf with black and white hairs distributed more or less equally in the coat. Such an animal is described as a "blue-roan" (there is no grey in cattle). But, although white is equal to black in this case, it does not share black's dominance over red, and a red roan calf results from the mating of a red to a white animal.

Numerous simple characters are dominant, but they mostly concern breed points such as shape of horns, coat colours and pattern, and other aspects not connected with

productive abilities. For this reason, it is easier to preserve uniformity in the appearance of breeds than to ensure a level milk yield.

Some genes are entirely responsible for a character, some only partially so, while others have a modifying effect. Others, unfortunately, may be lethal and cause the death of the calf before or after birth. Characters such as those governing milk and beef production are obviously highly important, and breeders aim at perpetuating the good qualities of their stock in future generations. Therein lies the art of breeding.

It is essential that the qualities which are apparent in one sex only—milk, for example—be found in both parents. The ability to milk is dormant in males, but they inherit the genes for its production and pass them on to their daughters Hence the necessity of choosing dairy bulls from high yielding strains or families

Example of Gene Expression in Cross Breeding Carried to the Third Generation

The Aberdeen-Angus breed carries two external dominants—black coat and hornlessness, while the Hereford's distinctive white face is dominant to plain face. Thus if we mate an Aberdeen-Angus bull (all black, hornless) to a Hereford cow (red, white face, horns), the progeny (generation F_1) will be black, white faced and hornless.

The recessive characters, the red coat and horns of the Hereford and the plain black face of the Aberdeen-Angus, have disappeared in the cross. These recessives are not completely eliminated and may return if the cross-bred animals which are, of course, impure or heterozygous for colour and horns, are allowed to breed. If sufficient numbers of the second generation (F_2) were bred, eight different types would appear. Between them, they would show every combination of the external features of the Aberdeen-Angus and Hereford breeds—all black, all red, black with white face and red with white face. In each type, both polled (hornless) and horned animals would occur. Those like the first generation of the cross—black, white face and polled—would be the most common, while all red, horned, would be the least frequent combination.

Were the cross carried to a third generation (F_3) by mating a male and a female of each type, only the all red, horned pair would breed true, as they have all the recessive characters of the two original animals with no dominants to override.

A recessive gene for redness is responsible for the occasional appearance of red or red and white calves in Friesian (black and white patches) and Aberdeen-Angus and Galloway (all black) herds. These are termed "throw-backs" and indicate that at some stage of their ancestry, red animals were used in breeding. It is when two animals carrying the recessive gene for colour are mated that red appears.

The polled condition is not fully dominant in some crosses, and when a polled bull is used on a horned cow, about 20% of the progeny may have "scurs", or horn buds which do not develop.

Blending or Intermediate Characters

The commercial qualities of cattle are less easily fixed. Milk and butter-fat yields and the ability to mature rapidly (important in beef cattle) are controlled by many genes and are termed multiple factor characters. These characters are only partly dominant and may be described as intermediate or blending. Thus, a bull capable of producing 1,000 gallon daughters when mated to 1,000 gallon cows, will get daughters with a potential capacity of 800 gallons out of 600 gallon cows. The same ratios apply to butter-fat inheritance, although this is a distinct feature. Unfortunately yield and fat content often move in reverse directions, high yielding cows giving low quality milk.

Similarly, if a cow is too light over the rump and shallow in the body, mating to a bull strong in these regions will produce a calf intermediate in conformation.

Factors which Modify Inheritance

A 1,000 gallon bull and a 600 gallon cow will produce a calf with a potential milk yield of 800 gallons. The

calf's yield is described as "potential" because it has inherited the capacity to produce 800 gallons Many factors influence this potential, and the actual yield may differ from that of which the calf is genetically capable

The genes for good points in the parents, such as those for constitution, may not be completely dominant so that while it may be free from disease the general health of the calf may not permit of high yields Milk secretion is dependant on glandular functions and on the ability of a cow to digest and convert large quantities of food In the individual the glands may lack stimulus while the proportion of food used for milk production depends on the temperament of the cow, a restless animal requiring more food than a contented one Again, undesirable recessives may manifest themselves and reduce production

Mutations

An unexpected change in the expression of a gene may occasionally become evident These changes are termed mutations and occur as the result of chemical action and exposure to X ray They are frequently harmful and Dr Hammond (*Farm Animals*– Edward Arnold & Co) states that forms of sickness may be traceable to this source It is a mutated gene that is responsible for the malformed calves often dropped by Dexter cattle This mutation is recessive and expresses its full power when both parents carry it In this event the calf is aborted and dies Similar mutations, not yet identified may be responsible for the occasional appearance of monster calves in certain of the cattle breeds

Should a mutation affect the genes controlling milk production an inhibition of the yield could result On the other hand, the changes produced may be favourable and increase production or improve some other point The polled character and coat patterns of cattle are the result of mutations

In conclusion, it is evident that many physiological and hereditary factors are involved in fixing an animal's productive worth For an animal to be exactly similar to its parents or the exact mean between them, is obviously impossible

Environment

This important factor covers feeding, management and climate. It is vital in determining the relationship of actual production to inherited capacity.

No cow will attain her potential yield if she is reared badly, nor will the milk secreting organs develop fully if she is undernourished. Inadequate feeding during growth stunts the development of the whole system and retards vigour so that high yields become impossible.

Climatic conditions also have an effect. Cows producing 1,000 gallons on rich, sheltered land will show a drop if they are transferred to a high lying, marginal farm, no matter how good management may be.

A valuable Danish experiment showed the effects of different feeding levels. Two bulls of the Red Danish breed, by the same sire and out of similar cows were used, with the following results:

	Nutrition Plane.	
	High.	Low.
Age (at end of experiment).	2 yrs. 45 days	2 yrs. 44 days.
Food units consumed.	3,998	1,387
Weight.	1,558 lbs.	702 lbs.
Heart Girth.	204 cm.	158 cm.

Similar experiments are at the present time going on to find the effect of different levels of feeding on cows, but it may be confidently anticipated that the results will be substantially the same. Modified experiments already conducted point this way.

Following a survey of dairy herds in south-west Scotland (where the standards are high) the late Dr. McCandlish concluded that the increased yields secured at that time (1932) resulted from improved management rather than from better breeding methods. Breeding still left room for improvement and if this were attended to, still higher yields could have been attained.

These results and findings show that neither breeding nor management alone is sufficient and that a high standard of both must be regarded as complementary.

Acquired Characters

Many practical men contend that usage over several generations to certain conditions results in anatomical adjustment of the species, but scientists hold that characters can only alter following a chemical change in the genes responsible. The latter view must be taken as the correct one.

Many examples could be given in proof of this, but let it suffice to say that, in herds where it is the custom to dehorn calves, horns do not cease to be a feature of the strain.

Dairy cows do, however, display features not apparent in the natural state. Among these are the ability to produce milk many times in excess of calves' needs and to convert large quantities of unnatural foods to milk. *These qualities run on through succeeding generations, but only if the environment is suitable,* and it may be assumed that a young dairy animal turned loose would soon revert to the wild state and low production

A pointer to the truth of this may be illustrated by calvings in different circumstances A heifer calving at the farm is amenable to human influence. In contrast, the writer joined in a search for a calving dairy heifer which had been lost for some weeks on a remote hill, where she and others had been "summered". When eventually found, she had her calf beside her and was exceedingly difficult to approach Her milk yield for that lactation was much below that indicated by her breeding because the calf had been able to take only relatively small drinks from the udder and secretion was, as a result, reduced at the time when it should have been encouraged by stimulating foods and careful milking Had the heifer run on the hill for the whole of her lactation, she would, because of the small demand made on her and bare feeding in winter, have produced only the milk required by the calf Had she continued in milk over the winter (which is doubtful) the total yield would have been about 200-300 gallons.

It may therefore be said that, rather than acquiring characteristics of commercial value, the responsible genes of cattle, while not changed, have a wide range of expression which is highly sensitive to feeding and management.

Because they were thus able to respond to the improved environment of advancing agricultural systems, oxen survived other mammals as foster-mother to the human race. This trait has been aided by selection of suitable types.

Inheritance of Disease and Other Conditions

Diseases of bacteriological origin are not hereditary, although a disease may be communicated to the young while still in the womb, at birth if the dam's genitals are affected, or when the young animal is in close association with a diseased dam. Calves of unhealthy dams should therefore be removed at birth and pail fed. Calves from diseased parents may, however, be more *susceptible* to the parents' weakness.

On the other hand, animals may develop immunity to a disease to which their kind has long been exposed.

Certain abnormalities may, however, be transmitted, among them being the "rig" condition (one or both testicles failing to descend into the scrotum).

Injuries are not "passed on". Similarly, a cow with a high potential yield will transmit it to her daughters, even though she gives little milk owing to bad management or feeding. Should, however, the constitution be so reduced that her calves get a bad start in life, they may not be strong enough to realise their potential.

Superstitions

Many unfounded beliefs still exist. For example, crossing by a bull of another breed or using a cross-bred bull is imagined to affect the cow's future ability to produce pure bred calves, while the constant use of one bull on a cow is thought to result in increasing likeness to the sire in successive offspring.

The former notion probably sprang from the ability of bitches to conceive to more than one dog in the same heat, the second mating being unknown to the breeder, who usually thinks that bitches are settled by one service. (See *The Right Way to Keep Dogs*—R. G. G. Hancock, M.R.C.V.S.—Right Way Books)

At one time it was the custom to calve black breeds in dark sheds so that the calves would be black.

Breeding Methods

What has been said about inheritance and other factors modifying results illustrates that complete knowledge of an animal's ancestry and, where possible, its own productive capabilities, are necessary if it is to be used in constructive breeding. Fortunately, much has now been done to supply farmers with information which reduces uncertainty. Pedigree lists kept by Breed and Herd Book Societies are to all intents and purposes a guarantee that the animals included will breed true for breed points, and where milk and butter fat yields are also recorded, the "blending" values of stock can be seen and used profitably.

Mass Selection. This is still a common method. The principle is that "like begets like", but as the judgment is based on appearances it is valueless in the planned formation of a dairy herd. At best, this method can only be partially successful where beef points are the aim.

Cross-breeding. In this system, cows of one breed are mated to bulls of another. The method cannot be recommended for dairy herds, where the cross-bred animals are required to breed also. The problem would at once arise —what breed of bull to use on the cross heifers? If one of either of the parent breeds were used, the second generation would be more purely bred than the first cross and if a third breed of bull were brought in, the results would be too variable.

Pedigree Breeding. A pedigree is merely a list of ancestors' names and is useless as a guide to profitable worth. The only assurance to be gained from a pedigree is that the animal will, when mated to another pedigree animal of the same breed, produce offspring whose external characters conform to the breed standards.

Pedigree combined with Records. Pedigree recording is of more value than a simple pedigree. It gives the ancestors' showyard and milk records, and the latest of these are a useful guide.

In reading a recorded pedigree, it should be noticed that the good yields of the strain are handed down to each generation and that it does not include a varying range of figures. If good yields are consistently shown throughout the last four generations, the chances are heavily in favour of a young animal being similarly endowed.

Progeny Testing. While an animal's recorded pedigree and its own performance (in the case of females) are of value, even more important is its ability to pass on its good points, and Progeny Testing implies the use of bulls whose ability to hand down their potential to their daughters has been proved. *The use of Pedigree Recorded Progeny tested sires is the surest method of stock improvement.*

Some Breed Societies rule that a bull must beget six daughters reaching the required yield standards, while others insist on ten before he is proven. If the daughters are unselected (that is, the yield of all the daughters is shown and not only those which excel) the test is more valuable, and if a bull has sired ten or more high yielding cows, it may reasonably be assumed that he will continue to produce on a high level. He is then qualified to be described as prepotent for milk, or a "Proven Sire"

The cows concerned must also be considered. A bull siring a number of daughters which, however good in themselves, gave less milk than their dams, would be of little value. His calves should obviously improve on their dam's yields or, if these were of a very high order, at least maintain them.

Grading Up. By using pedigree bulls in each generation, a herd can be graded up to pedigree standards and, after a few generations, provided the foundation cows are approved by the Society, is acceptable by most of the Breed Societies for entry in the Herd Book. The Societies vary in the number of generations required before the animals qualify, the usual number being four. By that time, 93.15% of the herd blood is on the bulls' side, that of the original cows being practically eliminated. In terms of chromosomes, this means that in each generation, 30 are added by the sires, while of the 30 contributed by the original cows, the number is halved in each succeeding generation thus:—

	Chromosomes from sires.	Chromosomes from original cows.
1st generation.	30	30
2nd generation.	45	15
3rd generation.	52	8
4th generation.	56	4
5th generation.	58	2

This table assumes a proportionate division of the chromosomes in each generation. This is unlikely to happen exactly, but while a preponderance of chromosomes from the dams' could survive, the segration might equally favour the sires' side.

Although a few breeders object to this system animals produced by it are just as good as pedigree stock except for the slight risk of occasional throwbacks.

If, in addition to their pedigree, the bulls used on each generation are prepotent for milk yields, a sound commercial herd can be built in two generations, or about six years

Many farmers are grading up poor Shorthorn herds by using Friesian bulls. This provides an excellent example of an extreme type of grading up and the sequence that may be expected is detailed below.

The Friesian colour and markings are dominant to the Shorthorn coat and if after the first generation (Friesian × Shorthorn cross) cows are mated to another pure Friesian bull, the second generation would be typically Friesian in appearance.

Milk yields will also rise rapidly. Let it be assumed that the bulls chosen for mating with each generation have a potential of 1,000 gallons, while the average yield of the original cows is 400. Milk yield being a blending character, yields of around 700 gallons may be expected from the first cross, 850 gallons from the second and 925 gallons from the third generation. These figures are subject to variation by the adverse factors already described, but careful selection, management and feeding will do much to combat their effects. With ordinary luck, the tendency will be in keeping with the example given above.

It Scotland, some farmers are grading up Ayrshires to Red Poll standards, believing that they will get longer life as well as beef qualities. As uniform coat colour and hornlessness are dominant to patterned coat and horns,

the F_1 generation looks very much like the Red Poll sire, though white patches appear in some offspring. Experience has shown that in the F_2 generation, small horns or scurs occur in a proportion of the stock, but disappear in succeeding generations.

Inbreeding. When breeding is carried out between members of the same family it is described as "close" Inbreeding is the closest possible and includes such matings as a bull to his daughters, to his sisters and half sisters and to his mother. It provides the quickest and surest method of "fixing type", that is, the retention of characteristics through succeeding generations, but, it must be emphasised, bad points as well as the good ones are fixed, and in the double dose!

Inbreeding should only be used when the animals are of highest quality, and even then, undesirable recessives may assert themselves, as both animals are likely to carry them. Because of this, poor individuals appear amongst the progeny and must be culled. The greatest proportion of these will occur in the first generation and will normally lessen with each subsequent generation.

Inbreeding has been much employed in the improvement of livestock. For example, the foundations of the Aberdeen-Angus breed were laid on a herd which was inbred for 50 years, each bull being a son of his predecessor

Linebreeding. This is a less concentrated form of inbreeding, involving such matings as cousin to cousin and a bull to his own grand-daughters. The effects are slower and punish the breeder less for mistakes. The use of bulls of the same strain in each generation of a herd being graded up is a wider form of linebreeding and can be valuable in fixing desired qualities.

Inbreeding and the closer forms of linebreeding should only be used by breeders who know their stock intimately. They are mainly valuable in pedigree herds desired for the production of bulls and, particularly in the case of inbreeding, are unsuited to commercial practice. Possibly, views on the desirability of inbreeding will be modified. Monster calves are appearing in some pedigree herds and it is said that some breeders know that if they mate between certain of their strains, monsters will result. This comes of breeding for "fancy" calves, and calls for enquiry by the Breed Societies concerned.

Outcrossing. The object of outcrossing within a breed is to strengthen some aspect weak in the existing animals of the herd. Owners of many dual-purpose herds are constantly outcrossing to maintain the balance between milk and beef. Similarly, if a high yielding herd produces milk of low quality, a bull rich in butter fat inheritance may be brought in, even though he may reduce the yield for a generation.

The consequences of outcrossing must be carefully considered, as it is possible to improve one feature and to lose others of value. A case comes to mind in which a bull was brought in to improve udders, which he did, but left daughters below their dams' standards in general conformation, especially in the hind quarters. Further outcrossing was necessary to regain the lost qualities.

Culling. Culling, or the disposal of unsuitable individuals, is often regarded as a contribution to herd improvement. It is negative proceeding, and while frequently advisable, is not always easy for the commercial man to undertake. At present, when the average cow milks for only three years, one third of the animals must be replaced annually. In a herd of 30 milkers, the farmer is lucky if, after rearing for bull calves, deaths, and delays in breeding, he has the necessary ten replacement heifers ready each year without rejecting heifers or cows which are sub-standard. He must hope, rather, that the progeny will be better than their dams, and purchase his bulls accordingly.

When long lived stock is concerned, opportunities for culling and therefore for quicker herd improvement, are greater.

Artificial Insemination. A serious obstacle to herd improvement is the shortage and high cost of proven bulls coupled with the small size of the average English herd. Scottish herds generally are larger, but the British average is under twenty cows. The cost of an expensive bull spread over the progeny would be excessive, and artificial insemination appears to be the only means of removing the obstacle.

A.I. stations have been set up, under Government supervision, in many parts of England, and Scotland is slowly following suit. Semen is collected from the bulls and distributed to farmers of the area as their cows come on heat.

The period for which sperm can be kept alive varies with the species, being about five days for bulls and only a few hours for the sperm of boars. By A.I., according to Dr. Hammond, one bull can settle in calf 1,000 cows per annum, or all the cows of about 50 herds. This rate has been attained, but in general practice, the number is about 600 cows. By this method, the prospect of rapid herd improvement on a national scale becomes real.

Small farmers should adopt A.I. rather than rely on inferior bulls There is nothing magic or seriously contrary to nature about it. The bull mounts a cow captive in a service crate, and the penis is diverted into an artificial vagina which holds the semen. It is then diluted in a suitable medium and cooled. The farmer telephones the station when necessary and the semen is delivered and injected by a technician.

Normally, a bull discharges about 5 c.c. of semen into the vagina. In insemination by artificial means, the semen is injected by syringe straight to the womb entrance. The principle is the economy of semen, 0.1 c.c. when properly placed, doing the work of 5 c.c. Normal, healthy calves result, and several generations of animals bred by A.I. have shown no bad effects.

The rate of conception is rather higher by A.I. than by natural means, while individual cows are encountered which can be got into calf only when the syringe is used. In certain disease conditions, (see Chapters XII and XIV), A.I. is essential.

The cost per service is 25/-, so that, even for quite large herds, the cost over a period is less than maintaining a bull, even when initial cost and depreciation are excluded

A further branch of the artificial production of young is being investigated. When the egg is fertilised, the embryo is endowed with its full inherited characters and the dam thereafter acts merely as a source of nourishment and protection. Cows can, of course, produce only one calf per year, and to increase this rate, the egg of a good cow is fertilised by a good bull and removed and placed into the womb of a poor quality, but healthy cow. The embryo develops and is born just as though it had grown within its own dam, its genetic assets being unaltered by the foster mother.

The development of this system would mean that good

cows would produce a calf from each successive heat, and very rapidly a collection of superior animals would result. Indeed, the process may be greatly speeded by giving hormone injections which cause the cows to shed many eggs at a heat instead of one. However, many difficulties exist, the chief being the removal of the fertilised egg from the true dam and ensuring its acceptance by the womb of the foster mother. This work has already been done under laboratory conditions and work is proceeding at Cambridge and in America to find suitable technique for large scale use.

Sex Determination. Dairy farmers consider that to choose the sex of calves beforehand would be invaluable. Many suggestions by which this may be attained—such as facing the cow East or West at mating—are absurd, but the theory that one ovary produces eggs which accept "male" sperms while the other gives rise to "female" is still strongly held. This view is prevalent in human affairs It is believed that each heat should be counted after mating, as each ovary is believed to cast its egg in alternate heat periods. Thus, if a male calf is born as a result of the first mating, the second mating should be timed to occur when the *other* ovary is in season, when a female will be produced. Even in face of evidence to show that females possessing only one ovary have produced young of both sexes, it has been maintained that, as it is very difficult to remove an ovary completely, some tissue, capable of producing an egg, may have remained. However, in the cow, the right ovary functions more often than the left (in the sow this is reversed), so that a regular count is impossible. Moreover, litter females (sows, bitches, etc.) produce young of both sexes in each litter and therefore from each ovary.

Others believe that the sex of the offspring will be opposite to that of the stronger parent, so that the use of a very masculine bull will ensure a preponderance of heifer calves. This theory, though widely held, is also erroneous.

Nature's way of distributing sex (and the only one meantime) is by the sperms of the male which, by having alternate chromosome arrangements, carry the sex factor. Each egg shed by the female contains an X chromosome, while in sperm formation, one sperm receives an X chro-

mosome and the other a Y chromosome. When a sperm containing an X chromosome fertilises the egg, the XX combination gives rise to a female while a male is produced by the pairing XY.

Some strains appear to have a tendency for male or female production. At present, the only step that can be tried by a farmer who finds that an undue proportion of his calves are unwanted males is to introduce a new sire.

It has been said that, if sex predetermination were possible, dual-purpose cattle would be unnecessary, as there would be no bull calves to dispose of. In that case, an unmarketable surplus of dairy heifers would arise. Taken all round, the ability to predetermine sex could be a very dangerous thing.

Sex Linkage. In matings between certain breeds of poultry, the characters of each parent are apparent in the offspring of the opposite sex—the pullets bear the same markings as the male parent, and the cockerels carry those of the hen. This results from dominant colour genes carried by the sexed chromosome.

No sex-linked factors have yet been definitely identified in cattle.

Milk Recording. Milk recording rightly comes under the heading of livestock improvement. By its use, the yield of each cow is known and the selection of the best animals for breeding is facilitated.

It is argued by the decreasing numbers who still consider the system too much trouble that they can see for themselves which are the best milkers. To measure each milking for each cow and add up the 600 which comprise the average lactation is unlikely to be carried out accurately on most farms. To divide the number of gallons sold to the M.M.B. in a year by the number of cows in milk is equally futile, because it takes no account of the differences between individuals.

Some years ago the M.M.B. showed that non-recorded herds produced an average of 500 gallons per cow, while the figure for recorded herds was 680 gallons. Denmark pushed up her national average by almost 300 gallons in 16 years of recording and also improved butter fat yields, while the average of many individual herds in Britain has been raised by 180—200 gallons in 5 years.

When selling or registering animals, production figures

other than by official recording are invalid and it is therefore essential that all herd owners selling stock on performance become members of the Milk Records Association.

Recording would be even more valuable if the food consumed for each gallon of milk produced were known, and it is to be hoped that the system will be extended to include this data. That it is not difficult to keep is proved by many pig breeders who record the amount of food consumed for each lb. of liveweight gain.

Agricultural Shows. These have come in for much criticism, some of it justified. When judgment was based on inspection alone (still the rule at some shows) undesirable features were sometimes encouraged and concentration on external points designed to catch the judges' eye took the breeders' attention away from productivity On the whole, however, the rivalry engendered is a good thing, and despite bad laws, the cattle show has contributed to improved stocks.

Further reading. *Farm Animals*—Dr John Hammond, Ed. Arnold & Co. Ltd *Breeding of Farm Animals*—Chapman Pincher Penguin Books *The Milch Cow in England*—E. R. Cochrane, Faber & Faber, Ltd.

CHAPTER V

THE BUYING OF STOCK AND THE FOUNDATION OF A HERD

The Females. Pedigree or non-pedigree stock is the first question after the breed has been decided. Pedigree stock is the more expensive, and while every breeder's aim should be to own a registered herd, this goal must, in many cases, be delayed because of cost. It may therefore be more convenient to buy unregistered animals and grade up for acceptance by the Breed Society. The immediate receipts for milk are not likely to be influenced, as pedigree is not yet a guarantee of performance, though among recorded herds, the recent figures show the pedigree herds to be leading.

The procedure open to beginners is similar in both cases. The cheapest and possibly the safest way is to buy well-bred heifers, typical of their breed, in calf to good bulls. As much as possible should be found out about the ancestry of the animals, though this is not always easy in non-pedigree stock. It is assumed that the beginner would buy only from farmers who record their production, and the available records of related stock should be studied.

The sequence should then be on the lines described for grading up, using, preferably, progeny tested bulls, bulls with good milk yields behind them and themselves from proven sires, or artificial insemination by such bulls. Production of each female should be recorded, those not doing well, and their calves, being culled from the herd. No matter how much care is taken in choosing the original stock, culling will reduce numbers considerably in the first generation or two. However, a sufficient number of heifers should merit retention to build up the herd quite rapidly, making the further purchase of females unnecessary. Culling is, of course, a relative matter, and if good

bulls are used, the calves of disappointing cows should normally be an improvement on their dams.

When buying initially, it is unlikely that one breeder can supply all the heifers required, or that they will be in calf to the same bull. Consequently, the heifers and their calves will not be uniform in type and it is only when the first of the home bred calves are born that this feature begins to appear.

Heifers are advised for foundation stock to minimise the danger of buying in disease. Unless the breeder is honest, it is also probable that any mature cows offered for sale are of poor quality and are merely being profitably culled from the seller's herd. This could be true of heifers, but, provided they are well bred for milk, the owner's objection could only be on the scores of type, since yield has not been tested.

Heifers are not fully developed and some experience is required in forecasting how they will fill out. The body is not so round as in mature cows, the wedges less pronounced, and the udder and milk veins are smaller. It is easier, in fact, to describe the type to be avoided.

Poor general conformation may result from bad breeding or underfeeding. In the latter event, it may develop into quite a useful cow, but if the bone and skin are coarse, the case is hopeless. A fat heifer may be difficult at calving and the subsequent yield depressed, while if the condition is poor, yield may be reduced and the animal may be unable to withstand the strain of a full lactation. If unserved heifers are considered, excessive fat or poor condition will possibly result in sterility.

Even before mating (see Chapter I), the udder shows some growth, and an assessment of its potentialities is possible. It should be flat and neat, the skin velvety and loose, and of even development throughout. The teats are smaller and closer together than those of mature cows and should point straight down and be evenly spaced.

A good coat, bright, alert eye and a very apparent inquisitiveness, indicate good health and condition.

Stock should be bought privately on the breeder's farm, as the buyer can see the environment under which the animals have been reared and also related stock which may include the parents and possibly the grand dam, as well as sisters and half sisters. A more careful study of

pedigree and records than is possible from a sales catalogue can be made.

Draft sales are held annually by pedigree breeders, surplus bulls and females being auctioned, but obviously, the best of the females are retained for use in the breeder's own herds. If the breeder has scored successes at recent shows, the herd becomes "fashionable" and prices often soar beyond a level which can be justified commercially.

Dispersal sales, due to death or retirement afford better opportunities but special sales of all kinds entail additional risks for inexperienced purchasers. The animals are, of course, specially prepared with a view to looking their best and quite serious defects may be covered up. Breed societies also promote sales, when only pedigree stock is on offer.

Occasionally good, aged cows in calf to a good bull can be bought. These are usually cheaper than heifers and their female calves would be the real foundation animals.

In buying stock, study carefully the butter fat and solids-not-fat yields, as well as gallonage produced. Milk low in solids places the farmer constantly in danger of prosecution. It is also possible that in future, if a suitable scheme can be devised, milk will be paid for on a quality basis and those whose herds produce "watery" milk will be penalised by a lower price.

When considering performance and ancestors' records, remember that feeding and environment greatly influence production.

This is illustrated by an unhappy case encountered recently by the writer.

A novice bought a bare, exposed farm on which only moderate crops were possible It was stocked expensively with good animals from holdings concentrated on a rich and fertile plain. In the first year, the cows and heifers together averaged 1,007 gallons, but in the second the yield fell to 710 gallons, when, owing to the growth of the heifers, it should have exceeded the first year's figures. The position could have become worse, but various circumstances induced the farmer to give up and the stock was sold at a loss to a farm enjoying better conditions. Within a year, production rose to an average of 957 gallons.

It is impossible to say how the yields were influenced by management, although the newcomer had engaged a cowman who seemed able. Had our friend bought animals from a farm "rougher" than his own, they would probably have improved on their first year's yields and he might still have been in the business!

It is important that *stock be bought only from herds of sound constitution as shown by freedom from disease and long milking life.* It is also better, if means are limited, to buy a few good animals, rather than to aim at the highest possible number with a lowered standard of quality, provided, of course, that the farm is not so lightly stocked that grass grows away from the animals and becomes rank.

Selection of Bulls

There is no guaranteed method of choosing bulls, the nearest being by progeny testing. With young bulls, even though their ancestry shows consistent records of good production, some risk always exists of the individual failing to reach his family standards. The chances are highly in his favour, but it has frequently been found that bulls by the same sire out of similar cows and even full brothers have varied in their ability to pass on milking qualities to their daughters.

A bull is of necessity six years old before his daughters' yields can be known and because there is some difficulty in handling older bulls, few survive beyond their third or fourth years. Then the daughters are ready for mating and another bull would be required for their service. Few farmers are able to keep more than one bull, and as the older one is not yet proven (almost two more years must elapse before his daughters complete their first lactation) he is not really a marketable sire unless the herd is well known and his daughters appear to be outstanding.

There are also difficulties in using a bull of six years. He is heavy and liable to damage heifers unless a service crate is used and he is likely to be of uncertain temper and dangerous to handle if he has horns. Polled bulls are quieter than those of horned breeds, and while a polled or de-horned bull may also be vindictive, he at least lacks lethal weapons!

In practice, farmers are usually forced to rely on young bulls, bought in most cases before they are twelve months old. (At pedigree sales, the bulls offered are often of 6—9 months.) If care is taken in their selection, the risk is probably justified, although enough has been said in this and previous chapters to show that the payment of huge prices for such young bulls is stretching the point, if milk production is the aim!

The alternative is to use semen from proven sires, and while there is a possibility of scarcity even in this, the rapid increase of insemination stations should improve the prospects.

Before using a bull, he must be licensed by the Ministry or Department of Agriculture. There are three classes, viz.

1. *Dairy.* Bull's dam and sire's dam must have produced 600 gallons as heifers, 700 gallons with second calf or 800 gallons with third or subsequent calf. Yields must have been computed in 365 days or less.
2. *Beef.* Bulls of pedigree standard.
3. *General.* This class is necessary because many herds are unrecorded The animal must be of good conformation and health.

Ministry officers inspect bulls at ten months, and application must be made for inspection 28 days before the bull attains that age

Bulls failing to pass the test (it is visual and prevents the use of obviously badly bred or underfed bulls) are earmarked R and must be slaughtered or castrated.

Premium Bulls. Government grants for the purchase of bulls are given, on application, to groups of farmers owning herds too small to justify the cost of individual bulls The bull serves the cows belonging to the members and in this way the quality of stock is better than if each bought a cheap bull. These herds, collectively, comprise about 50 cows.

With this system there is of course, a danger of transmitting disease.

It is commonplace to describe the bull as "half the herd". This is an understatement for, although making an equal contribution with the cow to the calf's inherited factors, she produces only one calf per year, whereas he

influences every calf born in the herd. Thus he is the most important factor in determining the quality of future generations, and as such, he should be chosen with greatest care.

If a proven sire is being brought into the herd, the records of his daughters will speak for him, but for younger bulls a wider investigation is necessary. The records of at least his dam and both grand dams and any sisters and half sisters should be consulted, and his sire and grand sire should preferably be proven.

In assessing the records of female relatives, it is important to know the conditions under which the figures were attained, as some bull breeders strive to boost their cow's yields with a view to enhancing the demand. Many of the methods employed, although honest, are impracticable for a commercial milk producing farm and do not, therefore, give a true picture of the cow's abilities.

Cows are normally managed to calve at yearly intervals, allowing for some weeks of rest after the previous lactation Any considerable increase in the rest period and in the intervals of calving favourably influence the ensuing yield. The Ayrshire Herd Book Society is promoting a scheme whereby this will be prevented, dams being required to calve for the fourth time within 3 years and 6 months or, for another class, six times in 6 years 3 months

Another means of securing higher yields than may be economically possible in producer herds is to milk three, or even four times per day. Three times daily milking produces about 20% more milk than the normal twice, so that allowance must be made for this in considering records Further, the season at which the cow calved influences yield, one calving in October giving possibly 100 gallons more than a similar cow calving in spring.

Type

Commercially, milk potential is the most important aspect in stock selection, but is not the whole matter, and the type of animal must also be considered This is essential in pedigree herds and those being graded up.

Many features are demanded by breed societies which

have no bearing on milk production or health, and actually add complications to the breeders' problems. Shape of horns and nose colour, or even bad coat markings (where these do not indicate an impure strain) are surely examples of this, and failure in any of these points would prevent a pedigree breeder from using an otherwise excellent bull. It is time that there was some relaxation in those matters.

There are many other breed points which, although no scientific proof as yet exists, do actually appear from experience to be linked with milk yield and performance, and even commercial, non-pedigree breeders cannot afford to ignore them. Thus we know that a thick set, short-legged animal is likely to convert most of her food to flesh, while short plates, that is, the space between the pins and hook bones, limits udder development. Badly placed teats must obviously be a hindrance and close-set eyes have long been associated with treacherous temper.

It is also known that the bull influences the feminine qualities of the daughters. Although the teats of the male are but partially developed, it is important to see that those of the herd sire are properly formed and placed neatly, as he will then transmit good teat quality to his female offspring. *The bull should be chosen with a view to correcting any faults which may be apparent in the female stock.*

Thus, not only should the records of near relations of intended stock be studied, but the animals themselves should be examined to see if the desired points are inherent in the strain.

Conformation is of even greater importance in selecting stock for dual-purpose herds The animals must carry flesh over the ribs, back and rump, but where the herd has a tendency towards beef at the expense of milk, a bull of almost pure dairy type would be required to restore the balance. Some breeders have "fixed" dual-purpose type, which means that the herds breed true for good beef quality and satisfactory milk yields. These breeders often apply for a beef licence for their bulls and this, coupled with milk records behind them, gives a very fair assurance of a continuance of the type.

Type within the breed, the detailed points mentioned apart, must relate to the environment in which the

animals are to be kept. In all important breeds, there are several types adjusted to the conditions of the various localities. Animals reared on fertile land are generally heavier and larger and require to continue on a higher plane of management and nutrition than those distributed over poorer areas.

The beginner should be sure to consult the appropriate breed society. Much information will be offered, including particulars of Advanced Register and Register of Merit and the various qualifying standards for pedigree entry and so on. It is also wise to inspect as many herds as possible and to concentrate on those which seem to be of most suitable type.

CHAPTER VI

SYSTEMS OF MANAGEMENT AND POLICY

General Notes on Management

A wide range of soil and climatic conditions has forced diverse systems of management on British dairy farmers. Cows are kept on every type of holding from all-pasture farms to highly developed arable units and, within that range, they hold positions of varying importance in the economic structure of the individual farms. The running of cows varies between permanently housed herds and those kept outside through all the seasons and between farmers who rear all their female stock and those who do not breed at all. Generally, standardisation of methods is found throughout each district, the natural conditions of the farms being similar.

In the areas of higher rainfall, the dairy herd is usually the chief concern. On these holdings, grass is a prominent feature and cropping is planned to suit the needs of the herd, very little being sold other than milk. In drier and more typically arable districts, the dairy herd is often a secondary activity and has among its main objects the trampling of straw into dung and the conversion of surplus products to a marketable commodity.

The collection of income on arable farms is slow, as months elapse between the preparation for a crop and its sale. The regular monthly payments made by the M.M.B. relieves dairy farmers of much financial strain, and of all agricultural activities, theirs provides the quickest turnover.

Before discussing the various systems, it may be said that all farmers should breed their own female stock. Doing so gives continuity to the herd and, therefore, greater uniformity. Home breeding provides opportunities

for improvement with every generation which are, of course, denied to the farmer who buys his cows, as he must obviously start afresh with each animal introduced. It also reduces the dangers of importing disease and gives better financial returns, as the heifers reach the milking sheds at less cost than purchased animals.

The dairy herd reacts sharply to the degree of attention given it, and if the daily routine is erratic, performance will suffer. For this reason, it is better to have the unit sufficiently large to employ men whose sole duties are with the herd. A good herdsman is of primary importance.

Mixed Grass and Arable Farms

The most suitable farms for dairying are those on which the land is divided between grass and arable crops. Such farms provide the cheapest feeding, and best scope for health and the rearing of young stock. If the grass is regarded as a rotational crop, soil fertility throughout the farm is kept at a high level. Rotational grass has been a feature in Scotland for generations, but it was not until the Second World War that ley farming received an impetus in England.

Young grass is better than permanent pasture, but an assurance of reasonable moisture to allow seeds to "take" is an advantage Hence ley farming is more likely to remain popular in wetter areas. A proportion of the grass should be shut up for hay, silage or for drying. Under this system, the rotation for a field which has been well grazed and therefore dunged might be:—

1st Year. Potatoes, without dung, as sufficient fertility exists in the buried turf.
2nd Year. Mashlum (beans and oats) to use up the residue of fertility left by potatoes.
3rd Year. Turnips, with dung applied.
4th Year. Cereal crop, undersown with grass and clover mixture.
5th Year. Cut for silage, dried grass or hay.
6th to 8th Years Grazing and then back to the plough.

In each year, fertilisers would be necessary to balance fertility and increase yields.

By following a plan similar to the above the farm is self supporting in feeding stuffs and the land is cared for.

Grassland Farming. This is farming with a "dog and stick". When cereals and oil cake residues were cheap and easily obtained, farmers near industrial areas let their land remain in grass, possibly shutting off a portion for hay. This portion received the dung. The farms were usually overstocked, and this, coupled with the absence of cultivation, made the pastures bare and foul. All feeding, except hay (when this was grown) was purchased. Usually no stock was bred, the cows being fattened for killing as their yields failed, and replacements bought from rearing farms. This was thoroughly bad farming, but it paid.

There are, of course, many grassland farms on which the pasture is well maintained. On these farms, it is usually circumstances which dictate the policy. The cause may be wet clay soil unsuited to cropping, extremely thin soil, an unduly exposed position or labour difficulties resulting from bad transport.

The cattle are at grass in summer and except when feeding is brought in, they are dried off in autumn when they may continue to run outside, the grass being supplemented by hay and perhaps roots. If the position is too exposed they are housed and brought through the winter as cheaply as possible.

Arable Farms. Here cropping for sale is the main interest, livestock being kept mainly for the dung it produces. Formerly it was the custom to feed bullocks on these farms, but in many cases, dairy cows have been installed for the extra income they give.

The method of running the milk herd varies according to the planning of the farm. On some places, almost no land is maintained under grass, so that the cows are kept on winter rations and housed all year. On this type, rearing of young stock is almost impossible and some arable farmers do not breed, but keep "flying herds" on the milk and feed system. In a recent survey in the North of Scotland, milk from this class of farm cost 3d. per gallon more to produce than on farms breeding their own stock.

On the other hand, many arable farmers have sufficient grass for rearing, and male as well as heifer calves are

retained. These farmers, of course, stock dual-purpose breeds and fatten the steers either when mature or at about 15 months as "baby beef". These animals are rapidly fed, largely on concentrated foods, and spend little time at grass. When kept to maturity ($2\frac{1}{2}$—3 years) steers are reared mainly on products of the farm (see Chapter IX) and may be fattened in courts or on good grass, when a good return is obtained.

Housing

The steading is another matter in which, without the ability or willingness to spend money, the farmer must accept the existing conditions. Most farms suffer the drawback of having very old buildings, and management becomes largely a compromise between the ideal and how near one can get to it through adaptation.

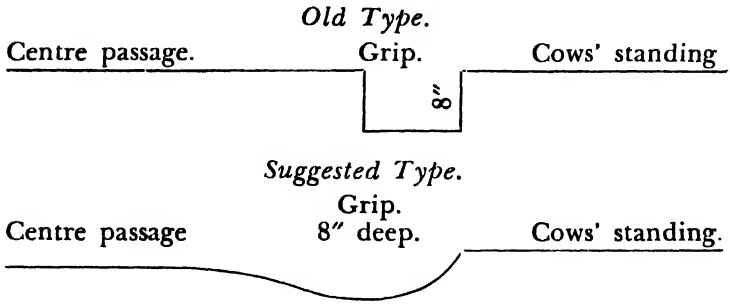
It is not proposed to discuss construction at length. The Ministry of Agriculture has carried out exhaustive research and the findings are incorporated in their reports—*Farm Buildings*—Post War Building Study No. 17 and *Farm Buildings for Scotland*—Post War Building Study No. 22.

All popular building materials are suitable, and the main conditions which a cow shed or calf box must satisfy are dryness and ample light, with good ventilation but no draughts. This is especially important in calf boxes and at floor level in cow houses. Chill air circulating just above floor level raises serious risk of udder troubles.

The floor is specially important, as it also provides the bed. Far too many floors are laid on the ground with no insulation against cold and damp, and if taking over a steading with floors of this type, they should be improved immediately.

This can be done cheaply by laying hollow bricks or drain tiles on tightly packed rubble and covering with concrete. In this way, capillarity is broken and a warm bed provided.

The "grip" or dung trench should not be sharply angled, as is found in older buildings, but should be of a type easily cleaned. The following sketch shows the old and the suggested types.



Cows Housed in Winter and Outside in Summer

This is the most common British system, being almost universal in Scotland. According to the region, the cows are turned out sometime in spring and housed again in October or November. In winter, they are allowed out for an hour or two, except in the severest weather.

In winter, the cows are fed and milked in the byres, but the use of separate milking sheds or "parlours" is spreading and is an aid to clean milk production. In summer, the cows are brought to the byres for milking, when any concentrated foods which they may receive, as supplement to grass, are given.

The cows are tied when in the byres and may lack sufficient exercise in winter. They are not easily kept clean, and with this in view, and to tone up the physical condition, they should be groomed twice weekly.

The confinement of cows in this way presents difficulties. Congestion, of course, assists the spread of any disease which may reach the herd and it is often difficult to spot those in heat, so that opportunities of service may be lost Through lack of exercise, calving is usually more difficult than when cows are at grass, although winter feeding contributes to the difficulty.

Byres must be cleaned daily and all urine safely led away. Unfortunately, on many farms this valuable product, containing most of the nitrogen excreted, is wasted. It should be trapped and sprayed on the fields. Hay is the most suitable crop to receive liquid manure, but if it is poured over an absorbent material such as peat moss, it becomes suitable for ploughing in.

The atmosphere should be kept sweet at all times and free of stuffiness. It has been found that 50° F. to 55° F. is the best temperature for milk production.

Courts. This system is a modification of the one described, covered courts taking the place of houses. It is more suitable for farms growing fairly heavy cereal crops, as more straw is needed for bedding.

It is the writer's opinion that this is the best way of running cows. It provides fresh air and exercise at all times, without the severity of systems which keep the cows in the field day and night throughout the year. The healthful conditions help to keep down tuberculosis and experience has shown that, once the cows become used to courts, yields are at least as good as those of housed cattle.

Horns are a nuisance and a danger in courts, and, unless a polled breed is chosen, female calves destined for the milk herd should be de-horned. Polled animals require less space than horned stock.

Yarded cows are milked in a milking "parlour", and receive their concentrates at milking. Roughages are fed from sacks and troughs in the courts.

Cows permanently Outside. This is a popular system in mild climates and on light, well drained land. The cows are milked in the fields, either by hand or machines installed in a portable bail. The bail is moved round the fields to avoid worn patches. The system was introduced by Mr. Hosier of Wiltshire (it is often referred to as the Hosier system), and is claimed that its use keeps cows healthier, that dung is excreted direct on to the land, and any reduction in milk yield is offset by lower labour costs.

Yields cannot be expected to reach those of sheltered stock, and it is obvious that the system is unworkable in areas of cold, wet land or where climatic conditions are unduly harsh.

Concentrates are fed in the bail at milking, while roughages are thrown on to the pasture.

Policy

The "business" policy to be adopted varies to some extent in accordance with the type and situation of the farm. Lack of transport, unsuitable buildings or short-

age of water may make it wiser to rear heifers and steers for sale, rather than to produce milk. In this sphere, however, some scope for personal choice exists within a given set of conditions. Thus, on a mixed arable and pasture farm, a normal milk unit may be run or, in the case of a pedigree breeder, the preference may be given to rearing bulls.

A brief description of possible activities, alternative to milk production is given below.

Pedigree Bull Breeding. This is highly specialised. It takes some generations to secure uniformity in a herd, and this is essential where bull production is the aim, as the breeder must be known for the "type" of his stock. It is not a branch open to beginners.

Before good prices can be obtained for bulls, a herd of high yielding cows must be built up. Each bull offered for sale must have an impressive ancestry and it is often necessary to seek showyard successes for the herd.

Even in a specialised and long established herd, few of the bulls attain the tempting prices so widely publicised. The pedigree trade is so exacting that bulls showing the slightest defect, as judged by breed standards and fashion, must fail.

Even when a good bull is born, much specialised attention is necessary to get him into the high priced lists. It is usual for these bull calves to be suckled by their dams or by a nurse cow, housing must be good and neither cramped nor crowded, and first class feeding available. The animals must also be trained to show-ring discipline and taught to walk well.

While the difficulties of bull breeding have been stressed, successful breeding makes a sound income. On one such farm known to the author, the income from bull sales is usually twice that drawn in milk cheques. The herd comprises about twenty cows averaging around 900 gallons annually, and no fantastic prices have been received for bulls.

Rearing Farms. There is considerable demand for heifers at various stages of development, both pedigree and non-pedigree, and for steers. Freshly calved heifers usually fetch best prices in autumn, as their milk is available for the high priced winter period, and the rearing of heifers for this season is often an attractive trade.

Steers are in demand for yard fattening in autumn, while graziers buy them in spring.

On some farms, heifers are sold when they drop their first calf, the female calves being retained until they in turn calve. Occasional calved heifers are kept back to rear the calves and are sold at their second calving. On pedigree farms of this type, bull calves are also reared for sale. Production records for the herd can only be traced by following heifers to their new owners.

On a decreasing number of remote, grassland farms, cheese and butter are made from summer milk, the cows going dry in autumn and being carried along as cheaply as possible until the following spring. Others situated in this way buy heifer and steer calves for rearing, a number of cows being kept for the purpose. One cow may rear 4—10 calves.

The calves are bought when a few days old from farms run so intensively that they cannot rear their own stock. They receive milk for a few weeks and are then run as stores until ready for sale to milk and beef producing farms.

A few farms of this type still produce summer milk for the liquid trade.

Tuberculin Tested Herds. The best time to start a T.T. herd is when starting farming, when it is merely a matter of buying healthy animals and having clean buildings and land to receive them. However, many farmers whose herds are not free of the disease are considering changing over.

If two steadings are available, the change can be made without wholesale buying and selling. It is an almost invariable experience that, although many, and in some cases, all, of the milking herd are reactors—that is, they fail to pass veterinary tests—the young stock on the farm are not infected, even although they are the daughters of diseased dams. Thus, if the reactors are retained on one steading, and young stock which have passed the tests and calves subsequently born are removed immediately to the other farm, they will remain healthy, but should be tested frequently. When sufficient of the young stock have reached the milking stage, the reacting cows should be cleared out.

Houses vacated by reacting stock should be thoroughly

disinfected and the whole wall and floor surfaces gone over with a blow lamp. The tubercle bacillus is exceedingly virile and may live for some months outside the body. To ensure that no danger remains, the houses should be left empty for a period of three months after treatment. Pasture grazed by infected animals should be ploughed and cropped.

For farmers occupying a single holding, the best and indeed the only way, is to get rid of all the cows and replace them by approved stock. The cost may be heavy, as T.T. animals are more expensive than ordinary stock, and yields, especially in the case of one who has bred his stock carefully, may be reduced until home bred animals again take their place in the herd. The extra price obtained for T.T. milk will do much, in a relatively short time, to nullify the loss.

Conditions are imposed by the Health Authorities for the running of T.T. herds, and the local representatives must be consulted. In the main, these provide for double fences round the boundaries to keep neighbours' stock from making contact, water laid on in the fields, streams fenced off, and buildings in which healthful conditions and cleanliness are easily maintained.

Graded Milks. These are detailed in the appendix, and it need only be added that the farmer should aim at the highest of the current qualities.

Retail. Farmers living near towns and villages may, by arrangement with the M.M.B. retail their milk. On the surface, this appears to be attractive financially, but many difficulties arise and the number of producer retailers shows a steady decline.

Although farmers thus disposing of their milk receive the retail price from their customers, a levy must be paid to the Board. Delivery expenses which usually include a motor van, wages for a man and boys and upkeep of bottles and equipment, are high. Slow and irrecoverable accounts provide a further source of loss.

Difficulties of maintaining a daily round are considerable. Demand is not steady, being highest in summer, while Sunday is a heavy day in most areas. To meet extra demand, milk may have to be bought from neighbouring farms and again, a surplus for which there is no outlet may arise.

Further worries are provided by the notorious uncertainty of delivery boys, the attention required to keep a van daily on the road, and the keeping of accounts Complaints by customers are almost inevitable and, while often unjustified, may cause a lot of embarrassment to a farmer mixing in the life of the community to which he sells.

Retailing appears to work best when production and sales are each sufficiently large to warrant separate staffs

Further reading. *Dairy Farming*—V. C. Fishwick, Crosbie Lockwood & Son, Ltd.

CHAPTER VII

THE FOODS AND THEIR USES

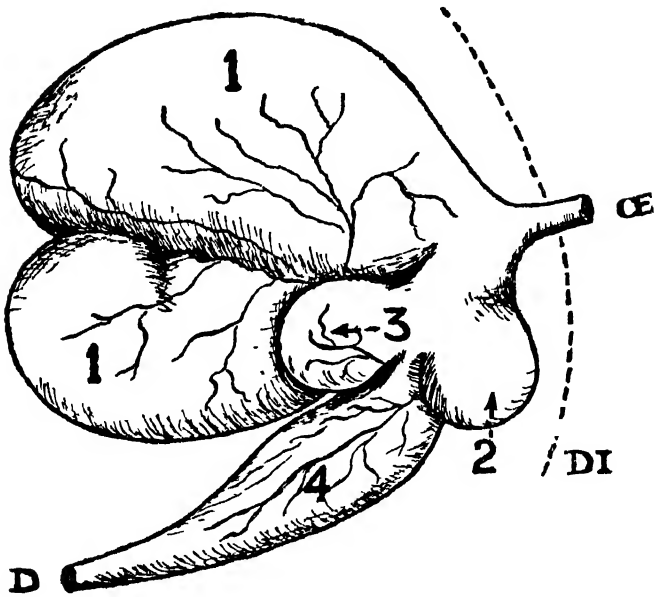
FEEDING is a keypoint in the success or failure of stock farming ventures. It is a principal item in the costs of production and has a profound influence on the health, development and productive powers of animals, thus controlling the income which may be expected from them. Accordingly, the value of foods and the purposes for which animals use them must be understood.

THE DIGESTIVE SYSTEM

The digestive system of oxen is complicated and has the huge cubic capacity of 45—60 gallons, according to the size of the animal. This is about ten times greater than the capacity of pigs which, at maturity, are one third to one half the size of cattle.

In effect, cattle have four stomachs within a single compartment—the rumen or paunch, reticulum, omasum and abomasum Food is immediately swallowed and stored in the rumen where it undergoes some change by fermentation and the action of bacteria. When the animal is at rest, this food is regurgitated in moist balls and chewed thoroughly for about a minute before being swallowed again This process is known as chewing the cud or rumination. (In observations, the author found that grazing cows took an average of 90—96 bites per minute, but chewed each ball of regurgitated food 50—60 times in 50 seconds.)

When food is re-swallowed, it by-passes the rumen and is carried to the omasum where it is further broken down by strong muscular action before going on to the abomasum or true stomach. There it is reduced to a fine consistency, and is then passed on to the intestine for final



RUMINANT STOMACH

1 Rumen or Paunch - *first stomach*

2 Reticulum or Honeycomb - *second stomach*

3 Omasum or Manyplies - third stomach

4 Abomasum, Reed, Rennet or *fourth* (true) stomach

Œ Œsophagus or Gullet

D Duodenum

DI Diaphragm

distribution as a liquid throughout the body and for the expulsion of waste products and the indigestible residue. The process as it occurs in the true stomach and intestines is largely similar to that of the entire digestive system of non-ruminant animals, and it is because of the earlier preparation in the rumen and omasum that ruminants can deal with fibrous and bulky foods.

The reticulum is not concerned in the treatment of solid foods, dealing mainly with water. Solids in suspense do, however, gain entry, and these are thrown up for remastication with the contents of the rumen.

The ruminant system is not developed at birth. At that stage, the abomasum is the largest of the compartments, but changes are rapid and at maturity, the rumen has the greatest capacity. Some weeks elapse before calves can deal with roughages, but it is essential that, as the full system grows, bulky foods are provided to enable it to develop properly. If such foods are not given, even though the calf receives other foods which on a chemical basis are sufficient, it will die.

Oxen are herbivores, but in domestication, small quantities of organic matter such as fish meal and meat meal may be fed. The bulk of their food is, therefore, obtained from plants, but the nutritional value of plants varies widely as does the value of different parts of an individual plant.

Good grass, with a reasonable addition of weeds or herbs, is the only single crop which can supply all the needs of cattle. In winter, when grass is not available, feeding becomes a complicated process entailing the use of many different plants with, quite frequently, supplementary feeding from other sources.

The Constituents of Foods

Water. An animal body is largely composed of water, the content being highest in early life, when it is about 70%. Beef contains 75% water and milk nearly 90% Water is necessary to assist in the assimilation of other foods and to cleanse the body via the pores of the skin and the kidneys. Moisture is constantly being lost from the body and must be replaced.

Animals obtain water directly or through their foods. Foods known as "succulents"—turnips, swedes, kale, etc., contain nearly 90% water, grass about 70%, while cereal grains are amongst the driest of foods with only 11% moisture.

Proteins. Proteins contain nitrogen. In the process of digestion, they are broken down to various amino-acids which, in turn, are converted to muscle (lean meat) and any product containing protein. They are required by mature animals for the repair of tissues wasted in the normal processes of life, but are specially important to young animals to provide for growth and to pregnant and nursing mothers for the formation of young and of milk. These animals, and bulls at stud, require proteins in relatively greater amounts than fattening bullocks which are kept in a manner which reduces wear to the minimum.

Proteins vary in biological value according to the source from which they are obtained, and are classified as follows:—

1st Quality. Those of animal origin, such as milk, cheese, fish and meat.

2nd Quality Proteins obtained from legumes—beans, peas, etc.

3rd Quality. Cereal Proteins.

The relative values are not fully understood, and better results are obtained when proteins from a number of sources are used in a ration.

Proteins fed in excess of an animal's requirements are used in the production of energy and body fat but, as under British cropping conditions, proteins are the most expensive part of the ration, the process is wasteful. Except in the case of milk proteins, it is also harmful, as the nitrogen contained cannot be fully used and its discharge through the kidneys results in strain.

Carbohydrates. In the course of digestion, carbohydrates are broken down to form sugar and are used for the production of heat and energy In this way, carbohydrates are essential to the normal functions such as breathing, digestion and movement. Excess of these substances is stored as fat in the body. The carbohydrates in cereal grains and potatoes are in the form of starch and as sugar in turnips and swedes.

Fats or Oils. Fats have 2.3 times the value of carbohydrates for the production of heat, energy and body fat. A limit is set on their use, however, as relatively small quantities can be digested and any excess might taint the product. Only oils of animal or vegetable origin are of use in nutrition.

Fibre. The fibre content of plants is highest when they are mature. Hay and oat straw are the chief fibrous products used in cattle feeding, and their bulk "fills" the animal and keeps it contented. Although the digestible content is low, these foods may be classed as carbohydrates. Oxen require these bulky foods for rumination and the production of body heat.

Ash (minerals). Minerals are essential for the proper development of the bone structure and for the general health of animals. Calcium and phosphorus are the chief requirements, but minute supplies of others are also necessary. Shortage of any one causes a deficiency disease of which anæmia and the wasting disease known as pine are examples. The first of these is caused by lack of iron and copper in the diet, while pine results from shortage of cobalt. Animals living in good, natural conditions usually get sufficient minerals from the herbage.

Though mineral licks are advised in later chapters as a precaution, it is better to ensure adequate supplies in the food, as they are then more easily assimilated. The only way to achieve this is by balanced manuring of the land on which the food is grown.

Vitamins. These are the accessory food factors which assist the body in the assimilation of other foods. While a food may be rich in certain vitamins, it does not necessarily contain a complete balance. Animals living in natural conditions are not likely to suffer from shortage, but for winter feeding, variety within the ration is essential to ensure that all of these factors are present. The following is a list of the commonly known vitamins, their properties, and the foods from which they are obtained.

Vitamin A—Anti-Infective. Assists the body in resisting disease. It is specially important to newly born animals.

It occurs in Colostrum (the first milk after calving), grass and all green foods, cod liver oil, animal fats and egg yolk.

Vitamin B Complex—Anti-Neuritic. Deficiency causes nervous disorders, paralysis and retarded growth.

Vitamin B is found in liver, yeast, cereal grains and their by-products, green foods and root crops.

Vitamin C—Anti-Scorbutic. Scurvy, delayed growth and possibly anæmia result from shortage.

This vitamin occurs in green foods, fresh fruit, root crops and sprouted grain.

Vitamin D—Anti-Rachitic. Vitamin D is necessary as an aid to the conversion of calcium and phosphorus in the formation of bones and teeth. Absence leads to rickets and malformation.

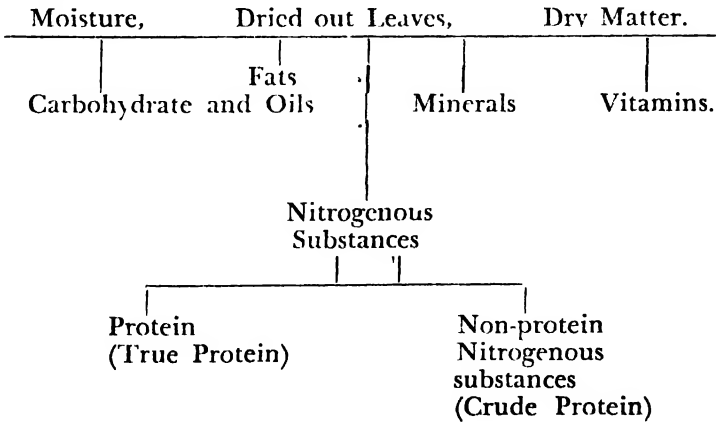
Vitamin D is specially important to animals which are denied sunlight. It is found in cod liver oil, animal fats, milk and good hay.

Vitamin E—Anti-Sterility. Animals suffering from deficiency may be infertile. It occurs in all green foods, so that grazing animals are well supplied. Green foods should be offered to housed stock which is required for breeding.

Vitamin K —Anti-Hæmorrhagic. Absence weakens blood vessels and delays blood clotting. Farm animals are unlikely to display symptoms of deficiency.

Vitamin K is found in pigs' liver, cereal grains and kale.

All foods suitable for animals contain the following constituents:—



Classification of Foods

Feeding stuffs have been further classified according to the proportion of moisture, fibre, carbohydrates and protein which they contain. No fixed rulings govern these groupings, which are:—

- *Succulent Foods.* Foods containing up to 90% of water. This group includes grass, potatoes, turnips, carrots, cabbages, kale and similar root and green crops.
- *Roughages.* These foods are bulky and contain up to 40% fibre, much of which is indigestible. They provide the bulk required by ruminants (cattle, sheep and goats) and by horses, which can deal with them because of the large capacity of the intestines, although the horse's stomach is relatively small. Pigs cannot d[redacted] foods.

Roughages include the various types of [redacted].

- *Concentrates.* Foods of high feeding v[redacted] bulk and containing less than 20% of water. [redacted] rations are usually made up of concentrates.
- *Protein Rich Concentrates.* 20—50% prote[redacted] contained in these foods and those used in anim[redacted] ding are obtained mostly as by-products of the f[redacted] oil industries, slaughter houses and dairy pl[redacted] The legumes, with protein content up to 25%, are [redacted] ded in this group.

Examples of this group are fish meal, lins[redacted] cake, cotton cake, blood meal, meat meal, separated milk and beans and peas.

- *Carbohydrate Concentrates.* Foods containing upwards of 50% carbohydrates and includes principally the grains of cereals.
- *Laxative Foods.* Protein rich foods, especially if the proteins are "immature" (as in young grass) are laxative. Succulents, oily foods and frosted roots have similar effect
- *Costive Foods.* Those containing a high proportion of fibre.

Cattle Foods in Common Use in Britain

It is impossible to include in a book of this type a description of all the foods which may be offered to cattle,

and the selection given is confined to those in most common use.

Roughages

Hay. This product is extremely variable in quality, both by reason of the grasses from which it is made and the method of making and storing. Good, leafy meadow hay, cut early and stored "green" contains the most nutrients per unit of weight, but owing to the heavier yields, "seeds" hay, comprising sown down grasses and clover, gives more food value per acre. Only superior quality hay should be given to calves and high yielding dairy stocks.

Lucerne hay, if cut before flowering, provides a high yield of protein. Sainfoin is also good and is similar to tares. Tares are usually more successful when sown with a supporting crop such as oats. When carting hay, it is important to see that the leaf is retained, as it is the most nutritious part.

Straws. Of the straws in use for feeding, oat straw is the most common and best and may be fed to store stock and low yielding cows. Barley straw may be similarly used, but wheat and rye straw are best used as litter. The leaves and pods of bean straw are good and may be fed to stores. Pea straw is similar in value.

It should be noted that as plants ripen, the nutrients are transferred to the seed. Straws, therefore, contain more food value and less fibre if the crop is cut before it is completely ripe. The digestibility of very fibrous straw is increased if it is first chopped into short lengths and then "pulped" by soaking for at least 3 hours in a 1.5% solution of caustic soda. After soaking, the mass must be thoroughly drained and then washed in clean running water for a further 3 hours. If washing is not complete, stock will reject the pulp. The process is costly in labour and requires a great amount of water, and has been found to confer no advantage where the crop was still a little green at cutting. For the latter reason, straw pulp is not used in Scotland, where the oat crop is cut before it is fully ripe, but it is considered to be profitable under English conditions, or when old straw is fed.

Succulent Foods

Grass. Grass is the most complete of all foods. It is, however, variable in quality and its value is controlled by season, the stage and rate of growth and the nature of the flora contained in the pasture. In spring the protein content is high, and, if the plants are not allowed to flower, the food value of grassland may be kept at a high level right through the grazing season. The leaf is the richest part and, consequently, abundant leafy growth is wanted.

The best top-grasses are the superior strains of ryegrass, cocksfoot and timothy, while rough and smooth stalked meadow grass provide a good "sole" to pastureland. Quality is, however, a matter of degree and what may be considered as weeds on good land may be the best that will survive on poorer land or at higher elevations.

Rotational pasture is best, as selected grasses are sown and maintained by manuring and management. As a grass field ages, aggressive grasses of poor quality and weeds smother the better types, and because of this, unless very good plants are indigenous to the district, permanent pasture is seldom of good feeding value. The fine old pastures of the Midlands of England retain their value because the ryegrass and clover of which they are composed are native to these parts.

It is instructive to note the excellent quality of grass seen on many roadsides, particularly where the road is of the old "dusty" type. These grasses rise from ground constantly kept rich in minerals from the dust deposited by wind and passing traffic, and it is sound economy to tether cattle on these verges if the conditions are suitable.

Clovers. Clovers increase the amount of protein which may be obtained from pasture and should, therefore, be included in seeds mixtures There are three main types—Red, Alsike and White. Red clovers are not so persistent as the others but provide excellent nourishment and bulk in short-term leys. Alsike is hardier and may be used where Red is known to fail.

Various types of Wild White Clover are indigenous to different localities. These clovers must not be allowed to become abundant in pasture, as they are responsible for a serious swelling (bloat or hoven) to which cattle are susceptible, and which frequently results in death.

Wild white clovers thrive excessively in over-grazed pastures, but, being of creeping habit, fail if the grass is unchecked. Carefully managed grazing keeps the correct balance.

Clovers have a beneficial effect on the land as, like other legumes, they have the ability to fix nitrogen and so increase soil fertility.

Dried Sugar Beet Pulp. This product, obtainable from sugar beet factories, should be soaked before feeding. It is a good production food and may be offered as part of the maintenance or concentrate ration. Owing to its high feeding value when compared to roots, it makes an excellent succulent for feeding to high yielding cows. For other stock, chaff may be mixed with the pulp to increase the bulk.

Silage. Silage made from good quality grass may be used as a production ration. Poorer grass and arable silage provide good fodder As silage retains most of the carotene of the original condition, winter milk from silage fed cows has a rich colour similar to summer milk.

Roots. Swedes followed by mangolds, are the best of the roots. Roots are helpful in keeping the digestive system sweet when stock is heavily fed on dry foods in winter. Mangolds are immature when harvested and should not be offered before New Year.

Wet Brewers' Grains. When delivery is convenient, these grains are a good succulent feed, but if they have to be transported long distances, the cost of carriage becomes excessive owing to the bulk of water While brewers' grains stimulate the milk flow, their use tends to depress the fat content.

Green Foods

Kale and Cabbage may be used in place of roots and to supplement failing grass.

Green Maize. A further good substitute for grass and is usually fed on the pasture in early autumn.

Sugar Beat Tops. Useful, either fresh or ensiled. When fed "fresh", the tops should be allowed to wilt for a week or two.

Lucerne. This is a deep rooted forage crop which provides good green feeding during the summer months and

is particularly useful in localities subject to long dry spells. It survives conditions of drought too severe for grass. Superior in protein to all but the best of rotational pastures, but, unfortunately, lucerne is successful only in South and South-East England.

Protein Rich Concentrates

Home Grown Legumes. Beans are the principal home grown source of protein. The proteins developed are believed to be particularly suited to milk production, and where the crop can be grown successfully, it is advisable to use it to full advantage. Beans do better and keep more free of disease when grown as "mashlum"—that is, when sown with oats. Peas are of similar value. Beans should be stored for a year before being used, but peas can be used fresh.

Proteins from Animal Sources. Possibly the best protein supplement available for growing stock is white fish meal, which, besides being rich in protein, is of high mineral and vitamin content. Small quantities of high grade meal do not taint the ultimate product (beef or milk), though cheaper meals made from herring and mackerel are objectionable on this account. The oil content of cheaper meals is higher and cannot be digested by very young stock, but may be given to stores.

Slaughter-house waste such as meat meal and blood meal are not so popular with cattlemen. The protein content of these meals is very high and they are useful when bulk must be kept to the minimum. They are, however, poor in minerals.

Sterilised steamed bone flour is frequently used in mineral supplements.

Imported and Residual Protein Foods

Linseed cake and meal are popular. They are richer in starch and poorer in protein than most products of this class and are included here because they usually form only a small portion of the ration. Linseed cake is one of the most frequently used foods for calves and in pre-

paring animals in which the best appearance is wanted. It imparts a fine gloss to the coat, but it is expensive.

Cotton seed meal is of high protein value, but, being unpalatable, must be masked with more favoured foods such as the cereals. Undecorticated cotton cake is costive because of the fibrous husk and is used to adjust the laxative qualities of some foods, especially young grass. Ground nut cake in decorticated form (i.e., the husk removed) is an excellent food for all classes of stock, being protein rich and tasty.

Coconut cake and palm kernel cake are "balanced" for milk production, that is, they provide the correct amounts of protein and starch, and as such they are very useful for adding to rations already balanced. Neither is palatable, but are eaten quite freely when cows become used to them. Coconut cake is deliquescent and sours in storage. Palm kernel cake has been used to supply the entire concentrate ration for dry cows being prepared for the following lactation.

Soya Bean Meal Of fairly recent introduction to this country. The protein content is much higher than that of homegrown beans.

Dairy By-Products

Skimmed, or separated, milk is the best milk substitute for feeding to calves. It lacks only the fat of whole milk. The dried form, reconstituted in nine times its weight of water, is theoretically similar to the liquid form, but results are not quite so good. Whey is of less value.

Carbohydrate Concentrates

Home Grown Carbohydrates. Oats are the most popular of all cereals for feeding cattle. Wheat, except in small quantities, is not easily digested and barley is best as a fattening food, though it is also suitable for growing stock and milking cows.

Weatings and bran are the principal by-products of milled wheat. Weatings are highly palatable and good for young stock, and bran is also greatly valued by stock-feeders. When fed as a mash, bran provides a mild laxa-

tive and because of this it is fed in this form at parturition and in cases of mild sickness.

Several by-products of barley are derived from the brewing and distilling industries. Wet brewers' grains have already been mentioned and except for moisture, the dried form is similar in effect.

Molasses is greatly liked by cattle and may be used in rations fed to high yielding stock and to animals which have gone off feed. It is commonly used by manufacturers to bind cubes and, incidentally, to camouflage unpalatable ingredients.

Imported Carbohydrate Concentrates

Maize is the most popular of all imported cereals, and though it is rich in carbohydrates and is therefore more of a fattening food, it is used for all classes of stock. Flaked maize is amongst the most palatable of foods and is widely used for young stock.

Maize gluten feed is balanced for milk production. Maize germ meal has somewhat similar value to oats and is eaten with avidity.

Dried Grass

Dried grass may be placed in a category of its own, as the best quality provides a concentrate food which is complete and balanced for milk production and supplies all the vitamin and mineral needs. The first grade is, as with all grass products, made when the plants are young and leafy and in a period of rapid growth. Second quality (" super hay ") and lower grades should be used as fodder. Grass may be stored after drying as a meal or in the long state. The latter is preferred by cattle.

The feeding of small quantities of dried grass (3—4 lbs. daily) in winter ensures adequate carotene for the production of milk of good colour.

As with silage, samples of the dried grass crop should be analysed so that it may be fed properly. In both cases, the quality of the original material and the efficiency of making, control the value of the final product.

Frequent cutting, say once in ten to fourteen days in a good growing season, results in a higher yield of protein per acre than if cuts were taken at less frequent intervals.

Dried grass may well become one of the most important foods in stock farming.

The Value of Foods

All foods in popular use have been analysed to find the amounts of protein, carbohydrate, fibre and fat which they contain. This is not sufficient, however, as a true guide to their feeding values, as animals can only use that part of the food which is broken down to liquid in the digestive tract and passed through the wall of the gut to the blood stream, when the real work of the food is done The indigestible portion is excreted, and if the excrement is also analysed and the nutrients found in it subtracted from those known to have been in the original food, the rate of Digestible Nutrients in the food is shown. This work has been done for most of the foods and in the Nutritive Tables issued by the Ministry of Agriculture, both sets of figures are shown.

The value of the Digestible Nutrients is expressed as Starch Equivalent (SE) and Protein Equivalent (PE) and it is in these terms that rations for animals are calculated

The SE of a food is the number of lbs. of starch which would give the same value as 100 lbs. of the food in question. Thus if oats are selected, it will be seen from the simplified tables given at the end of this book, that the SE is 59.5, which means that 100 lbs. of oats provide the same energy as 59 5 lbs. of starch.

The PE of a food is the average of the percentages of digestible crude protein and digestible pure protein, and if oats are again taken as an example, the PE may be worked out from the tables and will be found to be 7.6. Any energy value contained in the protein is included in the SE figure.

The PE/SE ratio of oats is therefore:—

$$\frac{59.5}{7.6} \text{ or } 1/7.8 \text{ (approximately } 1/8).$$

While the PE/SE value of a food gives a very good guide to its usefulness, it includes no assessment of the vitamins and minerals contained. Sufficiency of these factors is only to be assured by including in the ration, foods which are known to be adequate in these substances, but it is usually safe to assume that a good mixed diet will cover the animals' needs. If there is any doubt, then cod liver oil may be fed in small doses to cover any vitamin deficiency likely to occur, while a mineral lick should be made available to stock if there is any fear of shortage. Animals living in natural conditions, i.e., grazing on good pasture, normally receive ample supplies of both factors.

The palatability of a ration must also be considered and if a food which is disliked by stock is included, it must be kept to a very small proportion of the feed or the flavour should be "hidden" by more tasty ingredients. Similarly, if large amounts of straw are fed, the costive effect must be counterbalanced by a laxative food from either the succulent or oil-cake groups.

Dry Matter. The nutrients of a food are contained in the dry matter, the moisture being of no more value than water obtained from any other source. The dry matter of a food expresses the approximate bulk and in compiling a ration, this aspect must have attention so that the animal receives sufficient bulk to keep it contented.

For mature cattle, the weight of dry matter in the day's ration should not exceed 2½% or 3% of the live-weight of the animal and a useful guide is to feed 3 lbs. per live hundredweight. For very young stock, no figure can be reliably applied.

Feeding Standards

The nutrition requirements of animals are known and are expressed in the quantities of Dry Matter, Protein Equivalent and Starch Equivalent (DM, PE and SE) required daily. This statement is termed the Feeding Standard. The standards for each class of stock form a good guide to feeding but must be treated only as such and allowance made for any peculiarity of the animals, or abnormal living conditions. The need for departure

from the standards is most likely when very young animals or high yielders are considered.

When discussing the feeding of livestock, it is usual to treat the ration in two parts, viz:—

Maintenance Ration
Production Ration.

● *Maintenance Ration.* This is designed to keep the animal in health and to provide energy for movement, circulation, mastication, repair of tissue, breathing, and other essential functions and is based on animals kept in a reasonably rested condition. The maintenance demands of restless and excitable animals and those running in exposed places in winter are, naturally, higher than those kept placid and contented. Grazing animals travelling in search of food also require a higher allowance than those which are fed in houses.

The amount of SE required for maintenance by animals of different size is proportionate to the surface area of the body and because of this, a small beast requires more in proportion to its weight than a large one. However, as the requirements for various weights have been worked out and are tabulated in the following pages, there is no need for elaborate calculations by the farmer.

The PE requirement moves in direct proportion to the liveweight.

● *Production Ration.* This part is measured to cover the production which is expected from the animal. The calculation is easy where milk is the product, as it is simply a matter of giving sufficient nutrients to produce the quantity of milk given, plus a little to allow of imperfect conversion.

The feeding standards for a dairy cow of 1,000 lbs. liveweight and producing milk of average quality are:—

	DM	SE	PE
	lbs.	lbs.	lbs.
Maintenance (daily)	27	6	.6
Production (per gallon)		25	.5

The quantities of nutrients necessary for maintenance have been arrived at after a wide series of experiments.

In these tests, the SE requirement of cows and bullocks of 1,000 lbs. liveweight, varied between 4.0 lbs. and 6.8 lbs. daily, so that the standards shown allow a good safety margin for any inefficiency in conversion by the cow and for variations found in the analyses of different samples of the same food. The PE standards also allow a safe margin. Grazing animals may use a further 1 or 2 lbs. SE for maintenance according to the quality of the pasture. Theoretically, the PE requirement is not raised by exertion.

The production standard shown is based on the nutrients contained in a gallon of milk of average quality These are:—

SE	PE
lbs.	lbs.
1.75	0.35

and again, allowance is made for losses within the animal Maintenance rations vary according to the size of the animal and similarly, the production ration must be adjusted to the quality of the milk produced, as measured by the percentage of butter fat. The figures covering all breeds and qualities of milk likely to be encountered are shown below:—

Breed	Average liveweight.	Maintenance Requirements	
		SE	PE
	lbs.	lbs per day.	lbs. per day.
South Devon	1,450	7.6	0.86
Lincoln Red	1,300	7.1	0.77
British Friesian	1,250	6.9	0.74
Shorthorn	1,250	6.9	0.74
Welsh Black	1,150	6 6	0.68
Devon	1,150	6.6	0.68
Red Poll	1,100	6.4	0 65
Ayrshire	1,000	6.0	0.60
Guernsey	950	5.8	0.57
Kerry	850	5.3	0.51
Jersey	800	5.1	0.48
Dexter	650	4.4	0.39

(Ministry of Agriculture Commission on Rationing of Dairy Cows.)

% Fat in Milk.	Production Ration per gallon (additional to maintenance). SE lbs.	PE lbs.
3.25	2.25	.50
3.75	2.50	.50
4.00	2.60	.60
4.25	2.75	.60
4.50	2.90	.65
4.75	3.00	.70
5.25	3.20	.75

The production ration must, of course, be fed for *each* gallon produced, without involving any increase in the total weight of dry matter. Thus, for a 1,000 lb. cow producing 3 gallons at 3.75% butter fat per day, the ration should be:-

	DM lbs.	SE lbs.	PE lbs.
Maintenance.	27	6.0	.6
Production (3 gallons).		7.5	1.5
Total (per day).	27	13.5	2.1

In comparing the rations shown above, it will be seen that, while the ratio of the maintenance ration is PE/SE 1/10 and the production ration PE/SE 1/5, the final ratio varies according to the gallonage. For a 1 gallon cow, it is approximately 1/8, while for a 3 galloner it is 1/6½. The final ratio, of course, becomes still narrower as production increases.

Feeding standards for the production of liveweight (growth and fattening) are not so easily fixed because of the changes in the composition of the body which occur as age and fattening advance. The changes are most rapid in early life and standards are generally considered to be unreliable for stock of less than 5 cwt. liveweight.

The feeding standards usually adopted are those shown in Bulletin No. 48—*Rations for Livestock*, and are shown below by permission of the Ministry of Agriculture and Fisheries.

Live-weight.	Appetite *DM* per day.	Maintenance Ration per day *SE*.	PE required per day for Maintenance & Production
cwt.	lbs.	lbs.	lbs.
5	14½	4	1¼
6	17	4½	1¼
7	19	5	1½
8	20½	5½	1½
9	22	6	1½
10	23½	6½	1½
11	25	7	1½
12	26½	7½	1½
13	28	7¾	1½
14	29½	8¼	1⅝
15	31	8½	1½
16	32½	8¾	1⅝

FOOD REQUIRED TO MAKE 1 LB. LIVEWEIGHT INCREASE

Age and Condition of Animals.	SE lbs.
Under 2 years Stores	2
Under 2 years Fresh Condition	2¼
About 2 years Stores	2¼
About 2 years Fresh Condition	2½
Over 2 years Stores	2½
Over 2 years Fresh Condition	2¾
Over 2 years Half Fat	3
Over 2 years Fat	4

The protein requirements of animals do not increase with age after the period of rapid growth is past. Also, as fat contains no nitrogen, protein is not needed for its production. It is for these reasons that, while the SE allowance increases steadily with age and weight, the amount of PE remains almost stationary. The PE/SE ratio, however, should never be wider than is shown on the above table, except, possibly, in the last week of fattening before slaughter, when protein supplements such as fish meal may be discontinued to avoid any danger of tainted meat.

Calculating Rations

In practice, the basic ration for dairy cows is usually designed to cover maintenance and the production of one gallon of milk. This ration is fed to dry cows in calf and to those at the lowest point of their lactation and may therefore be regarded as the *minimum* for any cow in the herd. A very simple "basic" ration for a cow of 1,000 lbs. liveweight could consist of hay alone, and the quantity to be fed is arrived at in the manner described below.

We already know that the cow requires 8 5 lbs SE and 1.1 lbs PE contained in a maximum of 27 lbs dry matter From the Nutritive Tables it will be seen that 100 lbs of ryegrass hay contains 38 8 lbs., 5 75 lbs, and 86 lbs, respectively. So that if:—

38 8 lbs SE are contained in 100 lbs hay

$$1 \text{ lb SE is contained in } \frac{100}{38\,8} \text{ lbs hay}$$

$$8\,5 \text{ lbs SE are contained in } \frac{100}{38\,8} \times \frac{8\,5}{1} \text{ or } 22 \text{ lbs hay}$$

Proceeding in the same way with the other factors, we have the final result:—

	DM	SE	PE
	lbs.	lbs.	lbs
22 lbs Ryegrass hay contains	18 92	8 53	1 26

The amount of PE is a little higher than required, but the additional quantity is small enough to be negligible. In any case, a little extra protein may stimulate the milk flow

For higher production, more concentrated rations must be given, as a cow producing 3 gallons of milk could not eat the quantity of hay necessary to supply the nutrients demanded. In this case, the ration does come into the separate categories of maintenance and production. The former, including the first gallon of the yield, is usually provided by home grown, bulky foods such as hay, straw, kale and roots, while production needs are supplied from

concentrates, either home grown or purchased. As for each gallon of average milk the concentrate must contain 2.5 lbs. SE, including .5 lb. PE, it is not usually possible to supply this in smaller bulk than 3½ lbs., while of some mixtures, 4 lbs. are necessary.

To continue with simple ration given above as the basic (maintenance and 1 gallon) and with home grown oats and beans available, we arrive, by the same methods, at the following ration, which is adequate:—

	DM lbs.	SE lbs.	PE lbs.
Maintenance and 1 gallon			
22 lbs. ryegrass hay	18.92	8.53	1.26
Production—2 gallons			
4 lbs. oats	3.46	2.38	.30
4 lbs. beans	3.42	2.73	.79
	25.80	13.64	2.35

The simplest way to work out a ration is to work the production ration first and then to build up the required totals of PE and SE by adding bulky foods. When dealing with complicated mixtures, the correct results may no be attained at the first attempt and adjustment become a matter of trial and error, but with some practice, the system becomes quite easy.

To assist the reader who is not familiar with these methods, the nutritional value is shown against many o the rations in this book and it is suggested that he check a few of them from the tables provided in the appendix In this way, proficiency will be rapidly attained. *To be fully conversant with this system, which is merely a measure, is to ensure that the highest return will be got from each cow at lowest cost.*

CHAPTER VIII

THE REARING AND FEEDING OF CALVES

THE performance of dairy cows is far beyond that intended by nature, and it follows that as calves they should be reared in a manner sufficiently generous to permit the building of a strong and resistant constitution, able to withstand the strain of forced production. The future performance of the herd and its prosperity depends upon the heifer calves and their care must be one of the most important tasks in the dairy routine.

Calves born in autumn usually make better progress and are less subject to disease than spring and early summer calves. The result of a survey in South-West Scotland some years ago showed that 25% of calves born in spring succumbed to disease in one form or another, while of the autumn births, only 8% were lost. The losses were highest during February to April and fell when the cows went out to grass thus indicating a lack of vitamins and other nutritional deficiencies in the winter feeding of the dams during pregnancy.

The aim in calf rearing should be to maintain a steady growth rate so that the animals go on without a check. At birth, the average calf weighs about 7½% of its dam's weight which, in most breeds, means approximately 80 lbs. For the first three months, liveweight should increase by at least 1 lb. daily, after which growth becomes more rapid and a steady increase of 1¼ lbs. to 1½ lbs. should be made.

The season of birth appears to affect the development of heifers for a considerable period of their lives. R. Phillips (Journal Ministry of Agriculture, Sept, 1946) shows that, amongst groups of Shorthorn heifers born at different times of the year, those calved in the quarter October/December gained 737.5 lbs. liveweight in the first 700 days of life, while those born at other periods averaged

only 636 lbs. gain. Heifers born April/June showed poorest progress with a total liveweight gain of 606 lbs. in the period reviewed. In computing the monthly rate of liveweight gain, Phillips again shows April to be a very bad month. In early summer the daily gains were highest at about 1½ lbs., while in April, an actual loss of .30 lb. was recorded.

Growth' involves many changes in the proportions of different parts of the body. In the early stages, the organs of greatest importance to the maintenance of life are most developed and the animal has the appearance of being long legged and shallow of the body. Later, the body begins to deepen and the head and legs become less prominent. Similar changes occur internally, and proper nutrition and management can do much to guide growth towards the greater development of the commercially valuable areas (this is fully demonstrated by Dr. McMeekan and Dr. Hammond—*Farm Animals* by John Hammond, Edward Arnold & Co.). Thus, if a beef steer were fed on a low standard and allowed free range on poor land, at two years it would be thin, light over the rump, long legged and generally "rangy". The same animal properly fed and managed would provide a valuable beef carcase at that age, the body being deep with a thick covering of flesh over ribs and rump, and the whole appearance compact. In the same way, judicious feeding of dairy heifers diverts growth towards the mammary system and prepares the alimentary tract for dealing with large quantities of nutrients which are, in turn, converted to milk.

The Birth of the Calf

During the warmer months, cows may calve safely at grass, and in typical dairy practice, the dam and calf are immediately taken to the steading. In winter, calving in prepared loose boxes is best, but many farms lack these facilities and calving cows are kept tied in the shed with the milk herd.

Generally, cows manage quite well by themselves, but they should be watched and assisted if necessary. Difficulties are more likely to be encountered in winter when the cows lack exercise and fresh foods. It is at calving and when milking that the kindly handling of animals pays dividends. Cattle should always be under gentle

discipline and when difficulty arises, a cow which has confidence in the stockman will get through more easily.

Dates of service should be noted so that the approximate time of calving is known. The length of the gestation period, normally about 280 days, varies in individuals so is not a reliable guide.

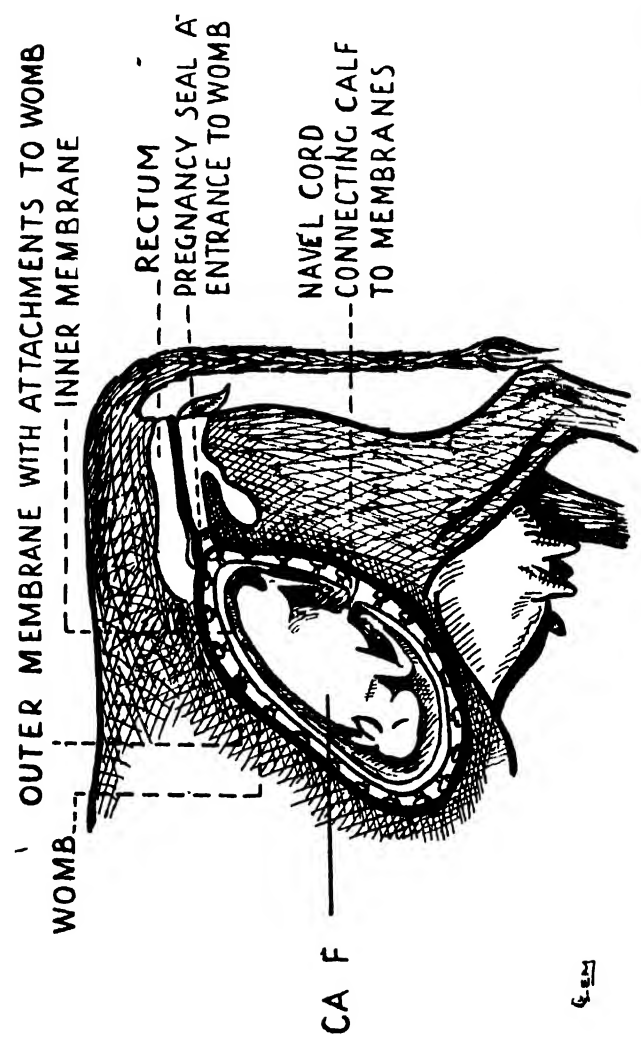
Prior to calving, the appetite falls and the udder fills and is hard and swollen. The vulva also swells, reddens, and emits a clear, viscous discharge The muscles round the tail head loosen and, in the final preparation. the cow walks in a peculiar fashion and is obviously distressed. While trouble should not be anticipated, no one without previous experience as an assistant should be in charge of an animal at this time.

For a period which may last for a day or two or only a few hours, light labour pains and straining are evident. These become more severe as the "water bag" appears. This bursts as a result of pressure. The front feet and, after an interval, the nose and head normally protrude. If the nose does not follow the feet, the hand should be inserted to find the position of the head, but this should not be done unless it is seen that the cow is in unusual difficulty. If the nose is held upward or to the side, it may be necessary to push the calf back a little so that the nose may be turned clear of the pelvic bone. It should be placed so that it lies between the front legs In some cases, legs become entangled and placed the wrong way. The hind legs, or one front and one rear may be felt first, while all four may come together, and if it is felt that the difficulty is beyond the attendant, veterinary assistance should be called immediately.

The most difficult part of the operation is the passage of the shoulders, and if the cow cannot manage by herself, thin ropes should be tied to the calf's front legs. The ropes should be pulled straight back from the cow, the pull being synchronised with her efforts. When the shoulders begin to come clear, the pull should be directed slightly downwards. (Towards the cow's feet and not towards the ground, as the cow may be lying on her side, though some stand while calving)

After the shoulders appear, the rest of the body and the rear legs come quickly. The navel cord severs in this part of the process

About 90 minutes is the normal time taken for calving, but this can vary greatly owing, chiefly, to the pause in the cow's labour after the expulsion of the head and again after the head appears.



CALF IN UTERUS

Courtesy of Home Farmer (The Journal of the M.M.B.)

The placenta (afterbirth) may be delivered a few hours after the birth of the calf or it may be delayed for some days. In other species, such delay would be fatal, but the cow is peculiarly resistant to troubles from this cause. The placenta may be entirely retained, or part may hang from the vulva. This begins to decompose after a day and the portion within the uterus may dissolve and be discharged. For safety, most vets like to see the cow no later than the second day, when injections are normally successful. Keeping the cow warm by covering with a rug will often help in stubborn cases.

The cow should be prevented from eating the placenta, which she is inclined to attempt.

It may seem superfluous to urge clean hands and equipment when dealing with births, but the writer has seen many calves delivered without the most elementary of precautions being taken. Also, when the hands are inserted in the passage, they should be lubricated by the application of vaseline or soap and water.

A few farmers are unbelievably careless at calving, and it says much for the resistance of cows that they survive. An almost incredible case was reported to the writer by a veterinary friend, who encountered a man who attempted to cure a womb infection by pushing a handful of sheep dip into the passage. The cow died: the farmer should have been locked up both for stupidity and cruelty.

Treatment of the Calf

As soon as a calf is born to a housed cow, the mouth and nostrils should be cleaned and the body rubbed dry with straw or a clean sack to assist circulation and breathing, which must begin when the navel cord is severed. The navel should be painted with iodine and tied with sterile string. These precautions are not necessary at grass, as the dam can lick her calf dry without assistance and the risk of disease entering the navel is much less. Calving pens must be thoroughly cleaned and disinfected before each birth.

In milk herds, the calf and dam are usually separated immediately, the cow being milked incompletely, and the calf housed in a dry, light and airy building. It is unwise

to crowd calves together, and if single pens cannot be arranged, then no more than three should be kept in a group. Crowding spreads disease by the usual channels and calves have the habit of sucking each other after feeding and may thus ingest harmful organisms. To avoid this, calves kept in groups should be tied during feeding and not released until their mouths and lips are cleared of food. Each pen should be separated from its neighbours by walls of the full height of the building, so that disease occurring in one pen will have less chance of invading its neighbours. (The pens should be fitted with hay racks, troughs and water. Great benefit is derived by the calves if they have free access to an uncovered yard in mild weather.)

In commercial herds, unless the calf is badly formed, all heifers are reared, but some assessment of their suitability should be made at birth. Extra teats have been associated with poor milk yields. Some farmers cut these off but the effect, of course, remains. A calf of obviously poor conformation should also be culled. The conformation alters continuously throughout growth, and at all stages the young stock should be watched closely and any not developing along the right lines kept out of the milk herd. The quality of the calf's dam should also be considered. If her production has been substantially below the general herd level, it would probably be a mistake to rear the calf and, if the dam is a first calver, her first lactation results will be known before the calf is many months old. If the sire was well grown for age as a calf, his offspring are better able to profit from good feeding.

An early decision on a calf's fate is important, as rearing is costly. To rear a calf for a lengthy period and then to cull her involves severe loss.

In dual-purpose herds, all calves are run on similar lines in their early months, so that to switch an animal from the milk section to beef makes little difference, except that the heifer is lost to the herd. This outlet is of great value to dual-purpose owners anxious to retain only the best heifers for milking.

Unless breeding is the object, bull calves are not usually retained. In the dairy breeds, they are sold for potted veal within a few days of birth when their value is only a few shillings, while in dual-purpose herds, bull calves are

castrated at three to four months and run on similar lines to heifers until they are six months old, or sold to other farmers for rearing.

The future of bulls intended for the pedigree market is even more of a gamble than that of heifers and many which are retained with a view to sale and breeding are rejected as faults become evident. The rearing of bulls for breeding is usually more costly than for heifers and steers and consequently the loss on a calf culled after some months' rearing is heavy.

Calves should not be turned out to grass before they are six months old unless they have run out with a nurse cow. Those born after June should be housed until the following spring, when they may be allowed out for increasing daily periods, preferably on rotation grass. If the land is known to be infected in spring by the organism causing Blackleg or Quarter Ill, the calves should be vaccinated against it, as attacks are always fatal.

A further danger to grazing calves is the husk worm, which invades the throat. When the grass is wet, the worm crawls up the leaves and is eaten. It is dangerous in autumn, and at this period, calves should not be put out until the dew has dried Mature cattle are more resistant to attack

Calves should graze on fresh, clean pasture and should be housed at night as soon as the nights become chilly—usually by the end of August.

(Although caution must be urged in grazing, this does not mean that calves should be closely penned. Exercise in the open air and sunlight should be available to them. To deny them this is to reduce their resistance to tuberculosis and other diseases.)

The age at which heat periods begin in heifers varies according to the plane of nutrition on which they are reared. About the fifth month is the average age for the first heat, but it is safer to keep the heifers away from bulls at four months and until they are required for mating.

The principal troubles likely in calf rearing and which cause most of the losses referred to are Nutritional White Scour and Contagious Scour. The former may be due to bad housing, chills, over-rich milk, milk with a hard curd, feeding cold milk, and overfeeding. The contagious form

arises from bacteria which enter the body via the navel and by feeding milk infected by mastitis. Attacks can only be avoided by clean and healthful conditions and the use of sound milk.

The incidence of trouble from nutritional scour may be reduced by good housing. It is interesting to note that on a farm with which the author had connections for some years, severe losses occurred annually, and disappeared when finally the calves were put into a building previously used for lumber. The only apparent difference was that the "successful" building faced south while the ther had a northern exposure.

Should attacks result from feeding over-rich milk, it should be diluted with 25% water. This should be a routine practice in herds of the Channel Island breeds. When a hard curd is suspected, 25% of water may again be added, together with 1 fluid ounce of a 15% solution of sodium citrate.

The effect of overfeeding milk is that the stomach is unable to dispose of the curd before the next feed is due. The bulk of the curd becomes progressively larger and more dense. Acute indigestion and scour result and the only cure is to replace a feed or two by offering water only. For a few days following, the milk should be diluted by 25%—50% water, when the stomach should return to normal.

The Feeding of Calves

Milk is the best food for calves, but the economics of dairy farming make substitutes necessary from an early age. Because of this, the natural suckling of the calf by its dam (the usual procedure in the management of beef herds) is not practicable, and the remaining methods open to owners of dairy and dual-purpose herds are the semi-natural and hand methods. Under each of these systems it is essential that for the first four days of life the calves be fed on colostrum, or the "first milk". They should receive their dam's milk or the milk of other freshly calved cows for this period at least, and the longer this arrangement can be continued the better the calf is likely to thrive. As the lactation proceeds, the curd of the milk

tends to become harder and a calf of, say, 4 weeks, may not be able to digest fully the milk of a cow in her seventh or eighth month of production.

Before going on to discuss these systems, it may be profitable to outline the properties of colostrum and its effect upon calves, and the general requirements of calves.

Colostrum is produced for about ten days following parturition after which the milk becomes normal. It has a brownish yellow colour and for the first four days is not saleable. In composition it is a little higher in butter fat than mature milk, and slightly lower in lactose but, whereas normal milk contains 12.8% dry matter and 3.4% protein, colostrum contains 25.5% and 17.6% respectively. Much of the excess protein is globulin, which is reduced almost hourly in quantity until it becomes merely a trace by the tenth day. The effect of globulin is to render the curd of the milk softer and more easily assimilated. Early skeletal development and the avoidance of deficiency diseases are provided for by ample mineral supplies.

Antibodies, which neutralise the effects of diseases to which the dam has been exposed, are contained in colostrum, while in addition, the Vitamin A (anti-infective) content is much higher than in milk produced later in the lactation. The amount present declines rapidly during the first few days after parturition when, as a result, the protective qualities of the fluid are greatly reduced It is thus important that calves receive colostrum, the production of which coincides with their birth, from the beginning of life if the full benefits of its special properties are to be gained. The first feed should be given to the calf as soon as it is on its feet, which is normally about thirty minutes after birth. It should be given at blood heat (98° F.).

Colostrum also has laxative powers and expels the meconium, or first dung, and so clears the intestines of the waste products which gather during pre-natal development.

It is interesting to note that, when boiled, colostrum (up to the second day) coagulates. This is the well known "beesty cheese", which is almost solid and has little taste.

It has been found that colostrum produced by cows which have had insufficient rest following the previous

lactation is much poorer in Vitamin A than in those which have had a longer and ample period of recuperation. The amount present is also influenced by the food the cow receives, and all cows due to calve in winter and early spring should be given green foods, silage, or dried grass so that the carotene intake is sufficient.

The importance of feeding colostrum will be realized from the foregoing, and it is also clear that the practice of milking cows immediately before calving denies the calves the benefit. If, by the death of the dam or any other reason, it is not possible to feed colostrum, milk offered should be diluted by the addition of 25% water to assist digestibility and a mild laxative, such as castor oil, given to start the bowels working. A switched egg may also be included in each feed with advantage.

Any colostrum in excess of the calf's needs should be given back to the dam to drink.

While milk is the ideal calf food, a calf craves other foods when a few weeks old. Fibrous and bulky food is necessary for the development of the digestive system which, if not fully grown, will reduce the animal's capacity for heavy feeding when adult. It is also believed that incomplete development impairs the ability to utilise such nutrients as are consumed. Many farmers delay the feeding of hay and meal too long, and by the second or third weeks, calves should begin to eat small quantities of both. Indeed, hay has been offered at four days with success.

Unless the source is beyond question, milk fed to calves should be pasteurised. Many may doubt the wisdom of this on the grounds that heat treatment destroys certain of the properties of milk, lowering slightly, as is believed, the content of Vitamins A, B and C, the digestibility, and the rate of available minerals, especially calcium and phosphorus. These losses, however, are not serious and are not sufficient to warrant the risk of feeding infected milk.

In an experiment carried out a few years ago at the West of Scotland Agricultural College farm at Auchencruive, one lot of calves was fed on pasteurised milk, while a similar lot was fed on raw milk. In the end, the raw milk group had better coats and were a little ahead of the others. The difference was most noticeable in the bull calves of the two groups, probably because their higher

growth rate made them more sensitive to the slight variation in the nutritional values Rearing on pasteurised milk has long been the policy on many prominent farms not holding a T.T licence

Milk and gruels fed to calves should be given at blood heat (98° F.), and careful watch for digestive disturbances should be kept. All pails and utensils should be scrupulously clean, or scouring and other troubles will result. It is usual to feed calves after the morning and afternoon milkings, with an additional feed at mid-day for very young animals, and the times fixed must be rigidly adhered to.

Milk substitutes must be prepared in accordance with makers' instructions, and to any gruel containing linseed, boiling water must be added or prussic acid poisoning may be set up. The gruel may be mixed in the first place with cold water for convenience, but before feeding, the boiling water should be added and the gruel allowed to cool. The boiling water destroys the enzyme causing the poison and also destroys the acid formed when mixing the food with cold water *The observance of this point is exceedingly important, as severe losses have been suffered by its neglect* Indeed, some years ago, a farmer sued the suppliers of linseed because his calves had died after eating it, but he lost the case when evidence revealed that he had used cold water only in the preparation

Water. Many farmers contend that water freely offered to calves results in dropped abdomens, the condition generally referred to as "pot belly" This is not the case, and even though large allowances of milk are given, water should always be available from the third week onwards Calves may take anything up to 1 gallon per day per month of age—in a recent experiment animals of 15 weeks drank 3 gallons daily. For very young stock it is better to heat the water to a degree just sufficient to remove the chill

The Semi-Natural Method of Feeding

Cows unsuited to the milk herd for any reason other than disease may be used as nurse cows. These may be kickers, hard milkers or aged cows. Relays of calves are

put on to the nurse throughout the lactation and in this way, healthy youngsters are produced and much labour is saved.

The calves should be housed and the nurse brought to them three or four times daily for the first week, after which two visits per day will suffice. Some cows require "coaxing" to induce them to take foster calves, and a most effective way is to tie a rope right round the barrel just in front of the udder. The restraint is so disliked that, after a few applications, many cows will stand quietly if the rope is merely laid across the correct part of the back. Tying the hind legs is also effective, but does not always prevent the cow from attempting to kick the calf away.

The number of calves suckled depends, obviously, on the cow's yield and the total amount of milk to be allowed each calf. They should receive about a gallon per day for 50 to 100 days and in this way a 600 gallon cow will successfully rear 5 to 10 calves in a lactation.

To introduce a cow to this system, her own calf is removed at birth and returned to her three or four times daily. During the second and third weeks, another two calves should be brought in and allowed to suckle for ten to fifteen weeks according to the total allowance decided upon. Twice daily suckling will suffice when the foster calves are introduced. A further group of three should then be put on to the cow, though to receive the same amount of milk as the first lot, they would require to suckle for about two weeks longer. Thereafter, the cow is given another one or two until she dries off. The success of this system depends on the cowman's observation as, without milking her, it is impossible to tell the cow's actual output.

While the first calf (the cow's own) receives colostrum from her, the succeeding calves must get that of their own dam and are, in consequence, about a week old when put on to the nurse. They should be allowed to suckle their own dams, as, if pail fed from the beginning, it is very difficult to teach them to suck from a teat. Calves put to suckle towards the end of the cow's lactation should, preferably, receive their own dam's milk for at least the first two weeks, as "stale" milk is indigestible.

When the cow is brought to the calves, the feeding

must be supervised to ensure that each gets its share. The youngest and most backward should be allowed to drink first, as the richer milk which is drawn last may be too much for their digestion and cause scouring.

At three to four weeks, concentrates should be offered to the calves in the same quantities as will be described for pail feeding. Water and good hay should also be made freely available at this time.

The semi-natural method is most profitable when good, cheap grass is available.

Pail Feeding. This method is in almost universal use in commercial dairy and dual-purpose herds. It demands more care than is usual on many farms. Even then, results are not so good as when suckled, because the milk is taken more rapidly and probably also because of the bacteriological change which occurs in milk exposed to the atmosphere. It is thought that the altered "balance" acts unfavourably when in combination with the bacteria present in the calf's digestive system.

When rearing by pail, calves are usually removed from the dam at birth and not allowed to suckle, though for the first week they should receive their own dam's milk as soon as it is drawn As a calf at this stage requires about 1/10th of its own weight in milk per day, newborn animals of 80 lbs. must be given 8 lbs. or ¾ gallon daily in three feeds at blood heat. Some farmers allow the calf to suckle for the first four days, changing over to pail feeding at that stage.

The amount of milk to be fed depends on the price obtainable and the needs of the farm, though economics should not be allowed to rule too strictly. The total amount is usually between 30 and 100 gallons. Normally 30 gallons is about the minimum for safety, while 100 gallons gives an excellent start to the calf It is important to see that the calf is eating well of other food before reducing the milk allowance. When milk prices are relatively high, the latter amount is costly, and the feeding of 40—50 gallons will be satisfactory. The total has been reduced to 9 gallons (Agriculture—Nov. 1944) and in the case reported, the calves eventually gave good yields. It is believed that rearing on such drastically cut allowances may lead to an early breakdown when the animal becomes productive.

Whole milk only should be fed for the first three weeks, when the introduction of substitutes, either as gruel or dry concentrates, should commence. At three weeks, about 1½ gallons daily should be reached. Thereafter, the allowance may be gradually reduced so that milk is discontinued about the eighth week. As the milk is reduced, the substitute should increase.

If very generous rearing is planned, the milk allowance may be maintained at 1½ gallons for a few weeks after the third week.

Foods in common use for feeding to calves are—oats, flaked maize, fine weatings, linseed cake (broken), linseed meal, bean meal and white fish meal. Linseed is popular because of the gloss it imparts to the coat, while fish meal is rich in the essential minerals. These foods are given as milk substitutes, either as a gruel or dry. When fed as gruel, the fibre content should be kept low. Mixtures which have proved to be successful vary quite widely, the PE/SE values ranging between PE 18—22 and SE 65—75 per 100 lbs.

Gruel feeding is practised less to-day because progress on dry feeding has been shown to be at least as good, while the labour of cooking gruels and the dangers of erroneous preparation are avoided. Whether gruel is used or not, dry concentrates and hay and water should be offered in the third or fourth weeks.

A suitable plan for gruel feeding would be:—

Age of Calf in weeks	Whole Milk Gals. per day.	Milk Substitute lbs. per day.	Dry Concentrate lbs. per day.	Hay	Water.
0—1	¾ (Dam's milk)	—			
1—2	1	—			
2—3	1¼	—	a little to give taste.	Ad lib	Ad lib.
3—4	1½	¼	¼		from 3—4 weeks onwards.
4—5	1¼	¼	½		
5—6	1	½	¾		,,
6—7	¾	¾	1		,,
7—8	½	1	1¼		,,
8—9	¼	1¼	1½		,,
9—10	—	1½	1¾		,,
10—11	—	¾	2		,,
11—12	—	¾	2¼		,,
12—13	—	¾	2½		,,
13—14	—	¾	2¾		,,
15—16	—	—	2¾		,,

Gruels are normally mixed at the rate of 1 lb. meal to 1 gallon of water and offered at blood heat. Should dry feeding be preferred, the same quantities of milk as shown above may be fed, with the dry concentrates equalling the total of the amount shown for gruel and concentrates from the fourth week onwards. Thus, at the 6th—7th weeks, a calf fed on the scheme shown above would receive ¾ gallon whole milk and 1½ lb. dry concentrates.

To teach a calf to feed from a pail, the fingers should be dipped in the milk and the calf allowed to suck them. The hand should then be gradually drawn below the milk until the calf's mouth is touching the surface, when milk will be drawn round the fingers. After a few feeds the calf will drink alone. When dry feeding is to be commenced, a small quantity of meal should be put into the bottom of the milk pail so that, when sucking the last drops, the calf will get the meal and become familiar with it.

National Calf Starter was introduced during the war years for gruel feeding and contains milk products as well as animal and vegetable meals. It is excellent and will probably remain available for some years, if not permanently. Similar mixtures are made under licence from the Ministry of Agriculture by feeding firms of repute, while for dry concentrate feeding, either alone, with milk, or as a supplementary to gruel, National Calf Food No. 3 and the meals of the "follow on" type are available.

Should home made mixtures be preferred, the following are suitable:—

GRUEL FEEDING—LOW FIBRE CONTENT

	PE lbs.	SE lbs.
30 lbs. Oatmeal	2.28	17.85
20 lbs Linseed Meal	6.00	16.74
10 lbs. Wheat Flour	.96	7 16
10 lbs. Linseed Cake Meal	2.40	7.40
30 lbs. Pea Meal	5.46	20.70
	17.10	69.85

GRUEL FEEDING—LOW FIBRE CONTENT—*continued*

	PE lbs.	SE lbs.
30 lbs. Dried Separated Milk	9.27	23.61
30 lbs. Linseed Cake Meal	7 38	22.20
20 lbs. Oatmeal	1.52	11.90
10 lbs. Fine Weatings	1.30	7.31
	19.47	65.02

	PE lbs.	SE lbs.
30 lbs. Linseed Meal	6.08	12.74
20 lbs. Oatmeal	1.52	11.90
20 lbs. Linseed Cake Meal	4.99	14.80
10 lbs. Fine Weatings	1.30	7.30
30 lbs. Pea Meal	5.46	20 70
	19.35	67 44

	PE lbs.	SE lbs.
30 lbs. Fine Weatings	3.90	21 90
25 lbs. Linseed Meal	7.60	15.90
25 lbs. Linseed Cake Meal	6 10	18.50
20 lbs. Oatmeal	1.52	11.90
	19.12	68.20

	PE lbs.	SE lbs.
25 lbs. Linseed Cake Meal	6.15	14 80
20 lbs. Oatmeal	1.52	11.80
10 lbs. Barley Meal	.73	7.14
20 lbs. Dried Whey Powder	2.34	17.34
20 lbs. Separated Milk Powder	6.18	15.74
5 lbs. Fish Meal	2.65	2.95
	19.57	69.77

By substituting crushed oats for oatmeal and bran for barley meal, this ration becomes suitable for dry feeding. Rations of this type are to be highly recommended.

Mixtures for Calves—Dry Feeding

	PE lbs.	SE lbs.
30 lbs Crushed Oats	2.28	17.85
20 lbs. Linseed Cake (broken)	4.92	14.80
30 lbs. Flaked Maize	2.76	25.20
10 lbs. Cracked Beans	1.97	6.58
10 lbs. Fish Meal	5.30	5.89
	17.23	70.32

	PE lbs.	SE lbs.
30 lbs. Linseed Meal	9 12	19 11
45 lbs. Fine Weatings	5 85	32.89
10 lbs. Bran	1 18	5 96
10 lbs. Cracked Peas	1.82	6 90
5 lbs. Fish Meal	2 65	2.95
	20.62	67 81

	PE lbs.	SE lbs.
20 lbs Flaked Maize	1 84	16.80
20 lbs. Crushed Oats	1.58	11.90
10 lbs. Linseed Cake (broken)	2 46	7.40
30 lbs. Cracked Beans	5.91	19 74
20 lbs. Dried Separated Milk	6.18	15 74
	17.97	71.58

	PE lbs.	SE lbs.
40 lbs. Crushed Oats	3.16	23.80
30 lbs. Cracked Beans	5.91	19.74
20 lbs. Linseed Cake (broken)	4.92	14.80
10 lbs. Fish Meal	5.30	5.89
	19.29	64.23

MIXTURES FOR CALVES—DRY FEEDING—*continued*

	PE lbs.	SE lbs.
50 lbs. Crushed Oats	3.80	29.25
50 lbs. Cracked Beans	9.85	32.90
	13.65	62.15

	PE lbs.	SE lbs.
50 lbs. Crushed Oats	3.80	29.25
40 lbs. Cracked Beans	7.88	27.32
10 lbs. Fish Meal	5.30	5.89
	16.98	62.46

Note. The above rations have been made up in 100 lb. units to make checking easier for those who wish to practise the system

For practical purposes, rations may be constructed in parts by weight when, for convenience, each part may represent 1 cwt. Thus the first ration shown would read:—

3 parts Oatmeal
2 parts Linseed Meal
1 part Wheat Flour
1 part Linseed Cake Meal
3 parts Pea Meal

Subsequent rations will be shown in this way.

Although milk processing is largely abolished from farms, cheap supplies of separated milk are frequently made available by manufacturing companies. This commodity provides the best substitute for whole milk, lacking only the fat. To replace fat, an energy food is required and the addition of a tablespoonful of cod liver oil to each gallon of separated milk will suffice.

An alternative and perhaps better method of supplying the necessary energy is to add a carbohydrate concentrate such as oats or flaked maize to the concentrate mixtures designed for feeding with whole milk at the rate of 1 lb. to each gallon fed.

Separated milk should be started in the same quantities as for gruel, but the accompanying whole milk may be reduced more rapidly. The daily amount of separated milk should not exceed 3 gallons. It may, of course, be fed for as long a period as is desired.

Dried separated milk, or skim milk powder reconstituted with water (1 lb. powder to 9 lbs. or 9/10th gallon), gives a food chemically similar to separated milk. While in theory the same results may be expected, practice shows the dried product to be a little inferior in value It is nevertheless, a cheap and good food. It may also be mentioned that, when using either type reinforced so as to replace the fat lost from the milk, a higher rate of fatty acids is found in the excrement, indicating a disability to digest such fats as completely as butter fat. This is true also of gruel feeding.

Cod liver oil is, however, exceedingly valuable in the rearing of all young stock which is housed and small quantities (two teaspoonfuls daily) should be given to all such calves. In this way, supplies of Vitamin A and D are assured and the animals are compensated for any lack of sunshine.

In cheese making areas, whey may be procurable Whey bears little resemblance to whole milk, containing very little of the fat and proteins of the original while some of the mineral content is missing. Whey must therefore be reinforced by the addition of high protein meals and by a mineral supplement, though the latter is not necessary if fish meal is included in the concentrated ration.

From trials carried out at Reading University some years ago, the two rations shown below were found to be the most suitable. These are widely used

3 parts Linseed Cake Meal
3 parts Bean Meal
1 part Fish Meal

100 lbs gives — 26 5 lbs PE and 67 3 lbs SE

5 parts Bean Meal
4 parts Linseed Cake Meal
100 lbs. gives — 23 00 lbs PE and 69 70 lbs SE

MINERAL SUPPLEMENT (2½ LBS. PER 100 LBS. MEAL).
TO BE GIVEN WHEN WHEY IS FED.

1 part Ground Limestone.
1 part Sterilised Steam Bone Flour.
1 part Salt.

The need for these supplements to separated milk and whey is clearly seen if their analyses are compared with that of whole milk:—

	PE lbs.	SE lbs.	Lime CaO %	Phosphoric Acid P_2O_5 %	Potash K_2O %	Chlorine Cl_2
Whole Milk (1 gallon) ..	0.35	1.75	0.17	0.20	0.20	0.10
Separated Milk (1 gallon) ..	0.33	.83	0.15	0.20	0.20	0.10
Whey (1 gallon)	0.06	.61	0.10	0.10	0.15	0 07

Whey and separated milk may be offered earlier than gruel and have been fed at seven days. It is however, better to delay them until the calf is at least two weeks old.

It is interesting (and convenient) to note that, until they reach the age of four months, cereals need not be ground for dry feeding of calves. They are quite able to deal with whole oats and cracked beans, though oats are better crushed.

Weaning usually means the age at which the young animal is taken from its dam, but in dairy practice, the term really infers the stopping of whole milk feeding. In the rearing scheme outlined in this chapter, this is effected at two months. Weaning is a difficult time, and if care and attention are not given, a check to progress will result. The danger is greatest in calves which have been suckled.

To avoid a check, weaning should be done gradually by reducing the milk allowance by a small quantity daily, and ensuring that the calves are eating well from the trough. (The plan shown in this chapter gives a milk reduction of a quart per week, or about a teacupful daily.)

When weaning calves which have been reared by a nurse cow, the succeeding lot should be put to her and the weaners allowed one short drink per day for a few days. To avoid further disturbance at this time, the ration to which the calves have been accustomed should be continued for 3—4 weeks. Source of vitamins and minerals should be checked over, and it is usually advisable to make a salt lick available. Instinct will ensure that it is used and that the calves will take the correct amounts. Very little is taken by those on whole milk.

Sliced swedes or mangolds may be offered at 2—3 months, starting with 5 lbs. At four months the calf should be eating 3 lbs. concentrates, 3 lbs. hay and 7 lbs. roots. Thereafter, concentrates may be maintained at 3 lbs or increased gradually to 4 lbs. at six months if the animal is backward or if rapid progress is wanted. In either case, hay should be kept at 1 lb. per month of age and roots increased according to growth.

At six months, the period of calfhood ends. Up to that age, only the best quality of hay and other rations should be given, but subsequent feeding may consist of increased supplies of bulky foods with correspondingly smaller allowances of concentrates. For calves reaching this age in spring and summer, more freedom may be given at grass, though again the change over must be made gradual by the feeding of small amounts of concentrates and the restriction of grazing to an hour or two at first.

The final advice on calf feeding and management is that the programme be adjusted *to progress rather than to routine.*

Castration. Bull calves to be fed for beef should be castrated at 3—4 months. The best means of operating is by the use of patent castrators which sever the spermatic cords but do not injure the skin of the scrotum. In this way, the many possible complications of a wound are avoided. When operating, the cords should be pulled to the sides of the scrotum (they can easily be felt) and held there while the castrator jaws are applied about an inch above the testicle. The efficiency of the job can be checked by feeling the break in the cords. Some swelling, which normally lasts for a day or two, normally follows the operation.

De-Horning. Horns are troublesome and there is perennial agitation, particularly among Ayrshire breeders, to have all female calves dehorned. While the operation may detract from the appearance, the matter should be considered against the advantages to be gained under commercial conditions. Through being less nervous of each other, the temperament of the herd becomes placid, and bullying and injuries cease. R. L. Forrest reports that his herd of Ayrshires, kept in courts, jumped in production by over 100 gallons per cow after the entire stock was dehorned. (*Farmer and Stockbreeder*—26th October, 1948)

De-horning is best done when the calf is ten to fourteen days old. The hair round the horn bud should be clipped and the bud rubbed with a stick of caustic potash. The rubbing should be continued at short intervals until blood appears, when the process is complete. Damage to the surrounding skin is avoided if vaseline is rubbed round the area before operating. The stick should not be handled without some protection for the fingers, as injury will result from contact. A wrapping of paper over the part to be gripped will suffice, and as the stick is deliquescent, it should be kept in a stoppered jar.

Mature cattle may now be de-horned (by the vet) by anæsthetising the horn nerves. The operation is then painless, but precautions must be taken against the subsequent bleeding.

It is absurd to exclude bulls from dehorning when one so often reads of men being gored to death.

The indications are now that dehorned stock will fetch higher prices, as they are preferred in the United States and other countries, while their popularity is growing at home.

CHAPTER IX

MANAGEMENT OF STORES

FROM the age of six months until they become productive, dairy heifers and fattening stock (except when the latter are to be finished for baby beef at 15—18 months) are considered as stores. During this period, the animals should make no more than steady growth and in order to achieve this and at the same time to ensure the maximum development of the digestive tract, generous quantities of bulky, home grown foods are given. Feeding costs may be kept low at this time, provided sufficient nutrients for the animals' needs are contained within the ration. Underfeeding of stores is too common, with the result that their growth is checked and, as adults, they are unable to reach their true productive potential.

The methods of running stores vary throughout the country. They are the most adaptable of all classes, but a certain minimum of consideration must be given if optimum results are to be achieved

Those under one year old are usually housed from October—March. Courts are very suitable for stores of all ages as they permit exercise and reduce labour costs. Groups of 10—15 animals are easily handled and should be matched for size so that bullying by larger ones is avoided. It is the usual practice to group the spring and autumn born animals separately.

On typically dairy farms, courts are not available and young animals are penned in loose boxes or tied in byres. Care must be taken to see that tied animals are given the opportunity of exercise, and if this is attended to, the system is quite good in that bedding is saved and, so far as dairy stock is concerned, the beasts are trained to tying at an early age.

In their second winter, Red Poll, Ayrshire, Kerry and Shorthorn stirks may be outwintered if the situation is

reasonably sheltered. Free draining, light land is suitable, but on heavy land which poaches in wet weather, the stock is better housed.

Outwintering has the advantages of lower labour costs and usually permits of larger numbers being carried. The animals require more food than housed stock, but as a proportion is gained from the pasture, feeding costs are not necessarily increased. Outwintered animals do particularly well at grass in the following summer and because of this ready progress, outwintered beef stores (as shown by the heavy winter coat) fetch better prices from feeders than those housed in winter.

This is illustrated by an exceptionally well controlled Irish experiment, conducted over a period of 4 years. The animals were carefully grouped for breed and sex and were as follows:—

1st year—10 Shorthorn bullocks in each lot.
2nd year—10 Aberdeen Angus cross bred heifers in each lot.
3rd and 4th years—8 Aberdeen Angus cross bred bullocks in each lot.

In each year, 3 groups were run on different principles and the combined results were as follows:—

Group.	1 *Housed all winter*	2 *Outwintered* Grazing interchanged	3 *Outwintered* every 2 weeks
Average daily ration (winter)	†56 lbs. roots 2 lbs. concentrates Hay & Straw ad lib.	Hay and 2 lbs. concentrates Jan.—end March	Hay only
Duration of winter feeding	150 days	150 days	150 days
Average weight at start	819 lbs	819 lbs	819 lbs
Average weight at end of winter period	968 lbs	897 lbs	865 lbs
Average increase winter period	149 lbs	78 lbs	46 lbs
Average weight when Lot 1 joined others at grass	*949 lbs.	897 lbs	865 lbs
Average increase summer grazing (12 weeks)	93 lbs.	181 lbs.	195 lbs.

Group	1	2	3
	Housed all winter	*Outwintered* Grazing interchanged	*Outwintered* every 2 weeks
Average total increase (winter plus summer)	242 lbs.	259 lbs.	241 lbs
Cost of winter feeding per head	£15.16 0	£8.8 0	£6.15.0

† Group 1 received 3 lbs concentrates in 1st winter and 2 lbs in the three following years.

* Five of this group were withdrawn and are not included in the data for summer grazing.

Average age at start of winter period—21 months

This experiment is quoted by kind permission of the Department of Agriculture for Eire

The costs shown are calculated at selling prices ruling at the time of writing and are higher than would obtain on a normal costings basis. Nevertheless, the *relative* cost of each group is unaltered by price of feeding stuffs.

Assuming that each of the animals progressed at the same rate, the following are the gains made in each period:—

	Group 1	Group 2	Group 3
Winter (150 days)	1 0 lbs	0 52 lbs.	0 31 lbs. per day
Summer (12 weeks)	1 12 lbs.	2.14 lbs.	2 32 lbs. per day.

These findings are specially useful to dual-purpose owners running on their own beef stores

When animals are to be turned out in winter, the pasture should be closed to stock from early autumn, so that it carries more grass. Very bare pasture would necessitate more hand feeding. Winter grazing by stirks is also useful in that coarse grasses which have survived summer grazing are eaten down, and if the animals are withdrawn in spring, the better plants have a chance to develop.

One point, however, animals naturally select the driest part of the field to bed down in and the consequent dung accumulation promotes the growth of rank, hard grasses. If these are not cut, a derelict area will result.

The loss of dung to arable crops is a drawback to outwintering. The best dung is made in courts. Two year old animals produce about 1 ton of dung per month.

In many areas, two year old heifers are housed from

December to February or March, being allowed out daily for exercise. It is essential that heifers become accustomed to the conditions of the milk herd, and if these animals are tied, then the heifers should be introduced to the system before they are due to calve. The second winter is a good opportunity for training if the stock has been previously run loose.

Houses must be light and well ventilated, and if kept in courts, yearling animals should have 30 sq. ft. of space each, while older stock require 50 sq. ft. To keep the animals warm and clean and to absorb the urine, 14 lbs. of straw per head should be put down daily for bedding. The courts should not be cleaned until the animals go to grass, when the dung is carted to the fields and ploughed in. In this way, losses of plant foods are minimised.

The Feeding of Stores in Winter

Although the requirements of young animals change rapidly, the following standards may be taken as a guide on which to base feeding:—

Age in months	Live-weight lbs.	Total Dry Matter	Maintenance and Production for 1¼ lbs. liveweight Increase daily	
		lbs.	PE	SE
6	300	7.5	.8	5.0
12	500	12.5	.8	6.0
18	700	17.5	.9	7.0
24	850	21.0	1.0	8.0

When feeding to these standards, careful watch must be kept on the stock and feeding adjusted to needs. A useful guide for their application is:—

1 lb. fodder per month of age. Hay only up to 12 months.

2 lbs. roots or equivalent in silage or green crops per month of age plus sufficient concentrates to bring the ration to the correct balance.

The concentrate ration may be taken from any of the mixtures given for milk production (Chapter X) or may consist of simple mixtures such as:—(3 rations)

3 parts Oats
1 part Fish Meal

4 parts Dried Sugar Beet Pulp
4 parts Oats
3 parts Decorticated Ground Nut Cake

Decorticated Ground Nut Cake as the sole concentrate.

Suitable rations for housed dairy stores making average liveweight gains of about 1¼ lbs. per day are:—

Age 6 months.	DM lbs.	PE lbs.	SE lbs.
6 lbs. Good Hay	5.10	.47	2.77
10 lbs. Swedes	1.15	.09	.73
2 lbs. Concentrates Mixed	1.75	.25	1.25
	8.0	.81	4.75

Age 12 months	DM lbs.	PE lbs.	SE lbs.
6 lbs. Medium Hay	5.10	.27	2.31
3 lbs. Oat Straw	2.58	.02	.94
10 lbs. Arable Silage	3.46	.28	1.30
2 lbs. Concentrates Mixed	1.75	.25	1.25
	12.89	.82	5.80

Age 18 months	DM lbs.	PE lbs.	SE lbs.
5 lbs. Medium Hay	4.25	.23	1.93
10 lbs. Oat Straw	8.60	.07	3.14
10 lbs. Kale	1.39	.13	.90
10 lbs. Swedes	1.15	.07	.73
1 lb. Decorticated Ground Nut Cake	.86	.41	.73
	16.25	.91	7.43

Age 24 months	DM lbs.	PE lbs.	SE lbs.
5 lbs. Medium Hay	4.25	.23	1.93
14 lbs. Oat Straw	11.85	.10	4.35
10 lbs. Arable Silage	3.40	.28	1.30
1 lbs. Decorticated Ground Nut Cake	86	.41	.73
	20.36	1.02	8.31

If heifers are to be pushed on for early mating, the concentrates should be increased and bulky foods reduced accordingly. To these animals, and young bulls, no straw should be given.

For those in courts, individual rationing of fodder and roots is not necessary as, if they are well matched for size, each will satisfy its requirements from a general supply. Concentrates must be fed individually and given before the bulky foods.

For two year olds outwintered on poor grass, a full ration will probably be necessary, though with close observation, a limited feed of hay may maintain growth satisfactorily. In snow and frost it is better to give some concentrates. If the grass is good, it will probably suffice without additional feeding, but progress must be watched and extra food given if necessary. Old pasture should be used for wintering, as young grass is badly cut up in wet weather and the root systems may be damaged.

As they approach their second winter, stores wanted fat for Christmas should be penned and fed fattening rations.

Summer Feeding

In summer, stores are easier to feed, as average pasture is ample for their needs and provides sufficient margin to permit liveweight of 1½—2 lbs. per day. This may be illustrated as follows: —

	DM lbs.	SE lbs	PE lbs
100 lbs. average grass contains	20	11.2	2.1

	DM lbs.	SF lbs.	PE lbs.
Daily maintenance requirements of 24 months old dairy heifer weighing 840 lbs.	21	5.4	1.50
Additional requirements for grazing (say)		2.0	
Requirements for 2 lbs. liveweight increase		4.5	
	21	11.9	1.50

Thus 100 lbs grass which is comfortably within the appetite of hungry and active 2 year old heifers, supplies the nutrients necessary for an economical rate of gain. First class pasture should not be used for dairy stores, but is suitable for beef cattle of this age, when substantially larger gains may be made.

When housed in winter, animals should be changed over to grazing gradually by turning them out for an hour or two daily at first, increasing the grazing time so that they are out for the full 24 hours in about 10 days. In early spring, the protein content of the grass may be considerably higher than that shown and this, coupled with the high moisture content, makes it very laxative. To prevent scouring, a feed of hay or straw, or 3 lbs. cotton cake or crushed oats should be given daily before they go out. After a week or two this precaution becomes unnecessary, except when rain follows a lengthy drought. The rapid growth which follows gives rise to conditions similar to the early spring flush.

The feeding described should cover the vitamin and mineral needs of stores, especially if green food is given in winter or the grazing season is extended as long as possible. If the soil is poor in minerals, salt licks should be placed conveniently for the animals' use. Fish meal is a further reliable source of minerals and is the best food in this respect for growing animals

Water should always be available.

Mating. The age at mating is not so important as the condition of the heifers. Once a heifer is in calf, she has less chance of further growth and she should be of good size when served.

The lighter breeds may be stocked earliest, and average ages, as tabulated by the M.M.B., are shown overleaf:

alongside are shown the ages which may be regarded as the optimum:—

	M.M.B (Average)	OPTIMUM (Best)
Jerseys	20 months.	15 months.
Red Polls	27 months.	21 months.
Ayrshire	24 months.	21 months.
Shorthorns	27 months.	24 months.
Friesians	25 months.	24 months.

Mating time is also controlled by the time at which it is desired to introduce the heifers to the milk herd. It is normal practice to have heifers calving in autumn so that they must be mated in early spring. To accommodate this arrangement, ages at service may have to be delayed or advanced, and the heifers should be prepared accordingly. A Red Poll or Ayrshire heifer born in June would be mated in the January of its second year (18 months of age) if she were to calve in the following September. In this case the animal would require fairly generous treatment from birth and should be reared on the higher of the planes discussed. It should be remembered that the cheapest form of rearing is not necessarily the most economical, as an earlier start to production may outweigh the higher cost of better rearing.

On the other hand, marginal farmers who have insufficient food for large animals, often mate their heifers early, and as the sole object is to keep them small, rearing is not conducted on a liberal scale.

It should also be noted that heifers left unmated to ages in considerable excess of these suggested for the various breeds may prove very difficult to settle in calf when they are brought to the bull. Excessive delay in mating also results in large and coarse animals and, unless feeding is abundant, it is, within reason, generally better to keep the animals relatively small, provided they have plenty of "substance" and good conformation. While large animals usually produce more milk than small ones, it is often found that the latter have a higher "dairy efficiency"—that is, they produce more milk per unit of food consumed.

The usual method of serving heifers is to allow them to run in groups with a young bull. Under this system, it is

not usually possible to note the actual service or even to be certain of it. Heifers may, of course, be treated as cows and taken to the bull when they come in season.

Pregnancy. The strain of early fœtal development is not severe on heifers, and no special consideration in feeding is necessary, provided they are in good condition, until they are within two months of their time. They are then more correctly classed with the dairy herd, and their treatment will be discussed in the later chapters with that of milk cows.

The Bull and Bull Calves

Feeding, Management and Restraint

Where the information is appropriate, much has already been said of bulls, and this section covers only those points of management in which the bull must be separated from general herd activities.

Feeding

Bull calves being kept for breeding or for sale should be reared so that they increase steadily in growth, without becoming fat. They are usually allowed to suckle nurse cows, receiving up to 3 gallons milk per day, until nine months old, and in some cases they are given a succession of cows until ready for work at 15 months. Nurse cows are indicated, as it is seldom possible for a bull to run with his own dam, as her milk record is a principal factor in fixing the son's value. Where nurse cows are not available, pail feeding will do, but progress is slowed. In all cases, the calf should, of course, have his dam's milk for the first four days.

Hay and concentrates as described for heifer calves are suitable, though larger quantities are required to keep pace with growth. Cod liver oil, increasing from 2 teaspoons to 2 tablespoons per day, should be mixed with the meal.

At no time are bulls treated as stores. They are fed for maximum growth until 15—18 months old, when feeding must be adjusted to condition and the amount of

work being done. No rules can be laid down, but for average work, a mature bull should be given a maintenance ration suited to his weight, plus concentrates balanced as for milk production. A bull serving 50 cows should keep his condition on 15 lbs. hay, 40 lbs. roots and 4—8 lbs. concentrates. Fish meal should be included for young animals and it is advisable to give all bulls some green food. This may be given as bulky foods such as kale or arable silage, or as part of the concentrates, when grass silage or dried grass will satisfy requirements.

Management and Restraint

Calves change with growth and many disappointments reveal themselves as the months pass. Little can be done to alter features which do not develop as anticipated and besides the impossibility of changing physical characteristics, any "faking" such as dyeing hair is frowned upon by the Breed Societies. However, a little fat can cover a host of blemishes, and buyers have to be careful of this aspect. A "legal" improvement by interference is to train horns to the proper set. This is done by filing the shell of the horn to divert growth. If it develops an unwanted curl, filing the shell on the outside of the bend will cause it to grow straight. Metal cup trainers and weights may also be used.

As the bull grows, he must be disciplined to handling, and training on the halter should commence as soon as he is really on his feet. At 9 months, the nose should be pierced, by using a proprietary punch, and the ring fitted. Some weeks elapse before the nose is healed, and until that time, the halter should continue as the means of restraint. When about 11 months old, a staff or line attached to the nose ring should be introduced, but must be used only with care.

When he begins to work at 15—18 months, the bull may be turned out in a well fenced field with the heifers but, especially in the case of the lighter, horned breeds, he is safer housed after two years and the cows brought to him. The pens used for adult bulls must be strong, roomy and airy and the animal attains better health and vigour if an exercising yard is available. To keep him in control,

a rail or hawser should run under the roof of the pen and over the top of the door to a post at the far end of the yard. The small space necessary above the door will do no harm and permits constant ventilation. A line is then attached to the rail in such a way that it slides easily, and the other end attached to the nose ring. In this way, his movements are circumscribed. The door can be opened and closed, and when open, the bull can change his quarters freely. The bulls of the hornless breeds, of which Red Polls are the only dairy representatives, do not require such elaborate precautions and are usually docile enough to be housed loose. While dehorning of other breeds removes much of the danger resulting from attack, the temperament is not greatly affected, and care should be taken in their handling.

Exercise of vindictive bulls sets a problem, unless they are housed as described in a shed with a yard attached. If grazing, a chain trailing from the nose ring, or a rope tied loosely round the neck and attached to a log which trails along the ground, will quieten him. Blinders can also be relied upon.

As with other stock, bulls should be groomed frequently to keep them invigorated and clean. It is essential to change the bedding daily, as, even if a bull is tied and has a dung trench behind him, the urine by necessity falls on the bed and renders it wet and foul. Bulls are too often seen with muck caked on the flanks and hindquarters.

It is vital to keep the bull's feet in order. If the hooves become too long, leg action is distorted and walking and mounting may cause sufficient pain to keep him from working. If the pen has not a concrete floor, the bull should be exercised on a hard surface. Failing this, overgrown hooves should be pared down and the claws cut back.

Oxen are colour blind, and see only varying shades of grey. The belief that red irritates them is therefore unfounded.

CHAPTER X

THE FEEDING OF DAIRY COWS

JUST as milk recording is essential as a guide to breeding, it is equally vital in the controlled and economic feeding of lactating cows. Without it, only haphazard methods are possible, with the usual result that poor milkers are overfed, while the yields of potentially better cows are depressed by underfeeding, to the general herd level. It is an almost unfailing experience for those taking up recording for the first time to find that their feed bills drop while milk receipts rise.

The feeding of cows for a lactation really commences at the end of the previous lactation or, in the case of heifers, about two months before they are due to calve. However, as feeding and management prior to calving are rather different to the subsequent treatment, it is proposed to divide this chapter into two appropriate sections.

FEEDING AND MANAGEMENT BEFORE CALVING

Cows should be dried off six or eight weeks before their calf is due as any shorter period allows insufficient time for building up. There are two methods of drying-off. Some farmers milk once daily for a few days and then only on alternate days (the interval may be even longer) to discourage production, while others simply stop milking and seal the teats with collodion or a similar preparation. Foods which stimulate milk flow (concentrates and succulents) should be withdrawn and the final milkings done by hand.

The advantage of sealing the teats with collodion is that germs are prevented from entering. To apply the paste,

an egg cup should be filled and pushed over each teat. Care should be taken to remove any trace of grease from the teats or the collodion will not adhere.

The problem of drying off does not arise with some cows as they cease milking too soon, while a few continue in milk through several lactations without a break, despite efforts to stop the flow. This should be avoided if possible, as the calves born are denied colostrum, unless other cows calve at the same times, and there appears to be no doubt that a cow's total production is greater if she has rest periods.

While the opinion is now held that feeding during the lactation may slightly influence the composition of the milk, the principal factor in ensuring the best quality of which the cow is generically capable is to have her in good condition at calving. In an experiment carried out some years ago to test this theory, a group of cows was subjected to differing treatment for alternate lactations.

For the first and third lactations the cows were in poor condition at the start, while for their second and fourth calves, they were well rested and built up by good feeding. The result was that the butter fat and solids-not-fat content of the milk, as well as the total yields, were much better in the lactations for which the cows had been well prepared.

The reason for their results is that a high yielding cow cannot eat sufficient food to cover her needs while producing heavily and must draw on the reserves contained within her body, already reduced by the strain of calving. If the reserves are low to begin with, the nutrients available are insufficient to provide for maximum flow and quality, while in struggling to produce what she can, the physical condition is further reduced. When the peak of the lactation is passed, she will normally regain a little of her tone. Moreover, inadequate feeding during the latter stages of pregnancy inhibits the fresh growth of the alveoli. Without full development of the tissue, milk secretion is restricted.

The season of the year has also a considerable bearing on the cow's health. Cows due to calve in autumn have behind them months of fresh air, exercise and natural feeding with its attendant benefits of complete mineral

and vitamin supplies, and are thus enabled to approach calving in better condition than at other seasons.

Just how much pre-natal preparation should be given to cows and heifers is a matter of controversy. One side, headed by Professor Boutflour, advocates heavy feeding as parturition draws near. Professor Boutflour recommends that cows be "steamed up" during the dry period by feeding increasing amounts of balanced concentrates, starting at 3 lbs. daily when the cow is dried off and increasing this to 4 lbs. in the following week, 5 lbs. in the next, and so on until she is within a fortnight of parturition. During the last two weeks the concentrates should gradually rise until she receives, just before parturition is due, 75% of the food necessary for her expected yield. In this way, a cow which promises to yield 6 gallons daily should be fed the ration for one actually producing 4½ gallons. As milk gathers in the udder the cow should be milked even though she has not calved. It is contended that the cow is built up more gradually to her maximum production ration and the subsequent milk yield is enhanced. Professor Boutflour's own description of the system may be studied in the Journal of the Ministry of Agriculture, issued October, 1943.

The more general method of "steaming up" (Professor Boutflour's term) is based on the assumption that, in the last stages of pregnancy, the fœtus absorbs the same amount of food per day as is required for the production of 1 gallon of milk (when newborn, the calf requires rather less than 1 gallon daily as its total food supply), and the cow is fed on this basis up to calving. Her condition, of course, must be watched, and one in poor order may require considerably more food (say to the level of 3 gallons production) to bring her into shape. On the other hand one showing a tendency to fatness may be brought along on hay and water as difficulty is often experienced in calving fat animals.

The ration preceding parturition should be laxative, and for this purpose, succulents and perhaps linseed cake or bran should be included. Should constipation arise, give ½—¾ lbs. Epsom Salts in warm water. Suitable rations (approximately equivalent to maintenance and one gallon) are:—

	DM lbs.	PE lbs.	SE lbs.
15 lbs. Medium Hay	12.90	.87	5.70
40 lbs. Swedes	4.60	.32	2.92
1 lb. Oats	.86	.07	.59
1 lb. Beans	.86	.20	.66
	19.22	1.46	9.87

	DM lbs.	PE lbs.	SE lbs.
10 lbs. Medium Hay	8.60	.58	3.80
6 lbs. Oat Straw	5.16	04	1.80
25 lbs. Marrow Stem Kale	3.48	.26	2.32
1 lb. Oats	.86	.07	.59
1 lb. Linseed Cake	.89	.17	.73
½ lb. Fish Meal	.44	.26	.30
	19.43	1.38	9.54

Exercise is necessary for animals in calf, but they should not be run with more active stock for fear of damage to the fœtus.

During the last few days before the calf is due, the ration should be restricted and costive foods such as fodder kept to the minimum. A bran mash, bran and molasses or even small quantities of a normal ration, provided it is laxative, are popular feeds for this period and may be continued for a day or two after calving, when production rations are gradually introduced. It is desirable to continue the steaming up ration for the early post-natal period.

The cow should be given a warm drink of water and milked as soon as she is fit after calving, probably in an hour or two. Milking should be done frequently during the following few days, but she must not be stripped. The period is one for careful management based on the reactions of the individual cow, and treatment depends largely on the udder condition. No forcing foods should be given until it is approaching normal, and if the vessel is inflamed, it should be soothed by the application of hot water cloths after it is relieved by milking. Thereafter, the ration she is expected to require (based on an estimate

of her yield) may be introduced as rapidly as the condition permits. Until food is restored to her, she produces from her own body stores, and if the ration is not built up in a week or so, she may lose unduly in condition.

Recording begins on the fifth day after calving and it is therefore important that production be brought up without delay. To encourage secretion, the concentrates should be a little in advance of her needs for the production actually attained. Thus, if a cow yields 3 gallons per day in the early stages of her lactation and her maintenance ration is designed to cover the first gallon, she should be given about 10 lbs. concentrates—that is, 7 or 8 lbs. to provide for the extra 2 gallons actually produced and the surplus as a "bribe" to stimulate further production. If it becomes evident that she cannot justify the additional food, it should be withdrawn. The tendency, however, should always be to feed a little in advance of production.

Feeding During the Lactation

Winter Period

If the cow is to achieve maximum production she must obviously have adequate supplies of all nutrients necessary for conversion to milk. Besides assuring that the bulk and PE and SE are correct, other factors, chief of which are palatability, mineral and vitamin sufficiency, and the effect on the bowels and on milk, must have attention.

Palatability. A cow on forced feeding and tied indoors for the greater part of the day for half the year may easily go "off feed" if the ration is not suited to her taste. Some cows, and particularly high yielders, are very selective.

Cows are fond of succulents, good hay, the cereals and their by-products (bran, weatings and flaked maize), linseed and other foods with a high sugar content. Locust meal and molasses may be incorporated in a ration to cover less palatable foods and as a condiment to encourage cows to eat. A food which is disliked until the taste for it develops, such as palm kernel cake and soya bean meal, may be camouflaged by other foods and brought gradually

to a larger proportion of the mixture. Grains crushed or ground to a coarse meal are preferred to fine meals, and these are best fed dry. Dry feeding for all classes saves labour and is at least as effective as wet feeding.

Variety. Variety within the ration is important, but frequent changes are to be avoided. A good mixture is necessary to ensure that the cow's full needs are met, as little is known of proteins. For this reason, the concentrate ration should be made up from as many sources as is practicable and should usually include at least three ingredients. Exceptions to this ruling are dried grass and grass silage, which are sufficient in themselves as concentrates for cows yielding up to 4 gallons and 3 gallons respectively. A further simple ration which does not require any addition is the well known mixture of oats and beans. The proteins of beans are particularly suited to milk production and both foods are liked by cattle.

Minerals. Little is known of the mineral requirements of stock and to add to the difficulties, the mineral content of crops varies according to the supplies contained in the soil.

Normally, a good mixed diet of hay, straw, succulents and varied concentrates ensures sufficient for average yields, particularly if fish meal is included. The minerals of concentrates and dried grass are more easily assimilated than those contained in fibrous foods. To ensure sufficiency, mineral licks should be made available to the herd and especially to high yielders, or ground minerals should be placed in accessible places. To supply minerals separate from the ration is generally safer as excess is also harmful and, if left to themselves, animals will not take too much. The taste of minerals mixed in the feed will often cause animals to reject it.

Vitamins. Variety in feeding may be taken as meeting all needs though in winter, unless green foods are given, Vitamin E (anti-sterility) may be deficient. Shortage of this vitamin is undoubtedly the cause of many females failing to conceive when mated in December and the early months of the year. Green foods also keep up the carotene level and consequently, the milk produced is of better colour.

Effect on Bowel Action. The tendency in rations should be slightly laxative. Severe constipation is easily

detected by the straining of the cow, while milder cases are denoted by firm dung. Feeding should be arranged so that the dung does not "form". It should be sufficiently soft to lie almost flat. However, food which is too laxative passes out of animals before the nutrients can be extracted and a soft, almost liquid fæces is excreted.

Foods which Effect the Taste of Milk. If fed shortly before milking, some foods influence the flavour, and particularly that of butter and cream produced from the milk. Turnips and silage fall into this category, though at the West of Scotland Agricultural College farm, *sound* roots did not do so. Silage may also impart an "external" taint to milk and should be stored at some distance from the milking shed. These foods should be given after milking.

It is often difficult to trace the cause of taints, as they do not necessarily resemble the flavour of the food responsible. Thus, sugar beet tops and pulp impart a fish-like taste, as does fish meal. Heavy feeding on hay aftermath and kale, produce flavours difficult to describe.

Various pasture weeds are capable of producing taints but, unless cows were turned on to weed covered land, they would not get sufficient to do harm.

Maintenance Rations

For 1,000 lb. cows yielding up to 5 gallons daily (6 gallons for the larger breeds), the rations for maintenance and the first gallon may be taken from home grown foods such as hay, straw, swedes, kale and arable silage. As a rough guide, this part of the ration may consist of hay fed at the rate of 2 lbs. per cwt. liveweight, but, while hay has been recommended as sufficient, it is better to replace it in part by succulents. Succulents have beneficial effect on digestion, assist in keeping the ration laxative and, as "live" foods, they contain healthful properties not revealed by chemical analysis.

To replace hay by succulents, the following may be taken as roughly equivalent: —

1 lb. Hay = 5 lbs. Swedes.
= 4 lbs. Marrow Stem Kale.
= 3 lbs. Arable Silage.

Swedes have been found to give best results when fed at a limit of 50 lbs. daily, while good results have been achieved by feeding kale for maintenance only and providing for the first gallon by a concentrate mixture, or by other bulky foods.

In Chapter VII it was shown that 22 lbs. Ryegrass hay will provide for maintenance and the first gallon, giving the necessary 8.5 lbs. SE and 1.1 lbs. PE. To include 40 lbs. swedes in the ration while retaining the same balance, 8 lbs. of hay would have to be deducted and we have:—

	DM lbs.	SE lbs.	PE lbs.
14 lbs. Ryegrass Hay	12.04	5.43	.80
40 lbs. Swedes	4.60	2.92	.28
	16.64	8.35	1.08

Many farmers prefer to add oats or a similar concentrate to such a ration. The following mixture would result:—

	DM lbs.	SE lbs.	PE lbs.
13 lbs. Ryegrass Hay	11.38	5.04	.75
40 lbs. Swedes	4.60	2.92	.28
1 lb. Oats	.87	.60	.07
	16.85	8.56	1.10

These rations, giving about 17 lbs. dry matter, leave a 1,000 lb. cow able to deal with a further 10—13 lbs. dry matter to provide for additional milk. If the production ration is made up of concentrates to be fed at the rate of 4 lbs. per gallon (Dry Matter approximately 3.2 lbs.) she can deal with sufficient food to produce a further 4 gallons daily. This would bring the total dry matter to 30 lbs., which is just within her appetite.

If, however, a cow gave only 2 gallons of milk, she would be due only a further 3.2 lbs. DM in addition to the maintenance ration (which covers also the first gallon) and the resultant total of 20 lbs. Dry Matter may not be sufficient to allay her feeling of hunger and she will possibly eat

her bedding. To keep her contented, the ration should contain a further 6 or 7 lbs. dry matter (without adding to the nutrients) and this can be given by the inclusion of oat straw and reducing slightly the quantity of hay. The ration for maintenance and the first gallon in this case would be:—

	DM lbs.	SE lbs.	PE lbs
10 lbs. Ryegrass Hay	8.60	3.88	.58
10 lbs. Oat Straw	8.60	2.00	.09
40 lbs. Swedes	4.60	2.92	.28
1 lb. Oats	.86	.60	.07
	22.66	9.40	1.02

The ration is a little generous in SE, but this will do no harm and is obtained cheaply from the straw. Some extra SE will also be used in dealing with the straw.

If bulky foods are short on the farm, they may be used for maintenance only, concentrates being fed to cover all production.

Further rations suitable for the maintenance plus one gallon are shown below:—

Rations for Maintenance and First Gallon Production

Suitable for cows of 1,000/1,100 lbs. producing up to 4 gallons daily.

Suitable for cows of 1,250 lbs. producing up to 5 gallons daily.

	DM lbs.	PE lbs.	SE lbs.
7 lbs. Lucerne Hay	5.88	.71	2.48
4 lbs. Sugar Beet Pulp	3.60	.20	2.42
10 lbs. Oat Straw	8.60	.07	3.10
8 lbs. Oats	1.73	.15	1.19
	19.81	1.13	9.19

	DM lbs.	PE lbs.	SE lbs.
15 lbs. Marrow Stem Kale	2.32	.22	1.54
15 lbs. Swedes	2.87	.17	1.81
15 lbs. Seeds Hay	12.90	.73	4.93
	18.09	1.12	8.28

	DM lbs.	PE lbs.	SE lbs
15 lbs. Medium Hay	12.85	0.69	5.79
20 lbs. Arable Silage	5.40	.50	2.60
	18.25	1.19 -	8.39

	DM lbs.	PE lbs.	SE lbs
15 lbs. Medium Hay	12.85	.69	5.78
40 lbs. Sugar Beet Tops	6.48	.48	3.44
	19.33	1 17	9 22

	DM lbs.	PE lbs.	SE lbs
8 lbs. Medium Hay	6.85	.37	3.08
40 lbs. Swedes	4.60	.28	2.90
lbs. Straw	4.30	.04	1.57
2 lbs. Beans	1.71	.39	1.31
	17.46	1.08	8.86

	DM lbs.	PE lbs.	SE lbs.
10 lbs. Wet Brewers' Grains	3.24	.54	1.84
5 lbs. Oat Straw	4.30	.03	1.57
10 lbs. Medium Hay	8.57	46	3.86
2 lbs. Oats	1.73	.15	1.19
	17.84	1.18	8.46

Rations for Maintenance and First Gallon Production

Suitable for cows of 1,000/1,100 lbs. producing 5 gallons daily.

Suitable for cows of 1,250 lbs. producing 6 gallons daily.

	DM lbs.	PE lbs.	SE lbs.
10 lbs. Medium Hay	8.57	.46	3.86
20 lbs. Arable Silage	5.40	.50	2.60
2 lbs. Flaked Maize	1.78	.18	1.68
	15.75	1.14	8.14

	DM lbs.	PE lbs.	SE lbs.
10 lbs. Ryegrass Hay	8.59	.58	3.88
10 lbs. Arable Silage	2.70	.26	1.30
40 lbs. Swedes	4.60	.28	2.90
	15.89	1.12	8.08

	DM lbs.	PE lbs.	SE lbs.
40 lbs. Sugar Beet Tops	6.48	.48	3.44
10 lbs. Medium Hay	8.57	.46	3.86
1½ lbs. Wheat	1.29	.15	1.08
	16 34	1.09	8.38

	DM lbs.	PE lbs.	SE lbs.
4 lbs. Dried Sugar Beet Pulp	3.60	.21	2.42
4 lbs. Super Hay	3.00	.26	1.96
8 lbs. Medium Hay	6.80	.37	3.09
1 lb. Oats	.87	.07	.60
1 lb. Beans	.86	.20	.66
	15.13	1.11	8.73

In feeding these rations, it is not practicable to weigh quantities exactly. Reasonable accuracy is best ensured by

having scales convenient, so that an armful of hay or basket of roots can be frequently weighed as a check. If hay or straw are baled, the approximate weight of the bales should be ascertained. If the average bale is found to weigh 1 cwt., then the stockman knows that each should supply 10 lbs. to 11 cows. An observant stockman will become proficient if helped in these ways.

Some thought in handling bulky crops will improve efficiency. Marrow stem kale is most conveniently handled as a grazing crop, but if the plants are large, the method is wasteful as the cows reject the stems and tramp down half-eaten plants. To avoid these losses, the crop should be sown thinly and not singled, as in this way the plants remain smaller and a larger proportion of the crop is eaten. Alternatively, when large plants are grown, the day's requirements should be cut and thrown down on pasture. On heavy land, the last is the best method.

When harvesting bulky crops, an attempt should be made to weigh them. For instance, a cart of mangolds could be weighed and the number of loads counted. In this way, a rationing scheme can be worked out which avoids early shortage (and expensive purchasing) of a particular food.

The crops used to supply maintenance vary throughout the country and with the season. Hay, straw, swedes and thousand head kale may be used throughout the winter, turnips and marrow stem kale to New Year, mangolds and cabbages in the early months. If a crop fails or fields are cleared early, after, say, arable silage or early potatoes, catch crops may be taken to serve their purpose in winter. Italian Ryegrass sown as late as July or even August will give a good hay crop and some aftermath grazing in October, while mustard and rape sown in the summer months provides fodder two months after sowing.

Production Rations

The difficulty with production rations is that the range of crops sufficiently rich in protein which can be grown in this country is small. Obviously stock farms which are completely self sufficient are a great asset in times of emergency. With world surpluses of cereals and

oil seeds doubtful, it is important that farmers do their best to feed their animals from their own land.

The main sources of home grown proteins are beans, dried grass and grass silage. While beans do not always do well on lighter land, experience during the late war showed that they could be grown profitably on a fairly wide variety of soil types. Dried grass is still a costly crop, but the extension of drying plants should bring a material reduction. The remaining crop, grass silage, provides good yields of protein but, probably because of disappointing results which were frequently encountered when the process was widely adopted during the Second World War, it is not popular with farmers. In most cases, the method of making the silage led to the disappointments.

Silage

Many farmers could not get away from the "tower complex" in silage making, and when a permanent tower was not available, temporary substitutes found a great deal of favour. The principal factors in silage making are the exclusion of air and consolidation, and in using these temporary towers, great care was essential to achieve these objects. The degree of care necessary was not always given, and a product of poor feeding value resulted.

It is now urged that the best and cheapest method is to dig a pit two to five feet deep, in well drained land. Sufficient grass to make a layer 4 feet deep in the silo should be cut and allowed to wilt for half a day. The grass should then be loaded into the silo in layers of about 9 inches deep and each layer sprinkled with molasses. To facilitate distribution, the molasses is mixed with water at the rate of 1½ gallons molasses to 3 gallons water, this quantity being applied to each ton of grass ensiled. (The average yield of young grass is 3—4 tons per acre.) When the whole cut has been loaded into the silo it should be left until it heats to 100° F. Twenty-four hours should suffice for this temperature to be reached.

The material should then be consolidated by driving a cart or tractor to and fro across it. The silo should be built up in this way, approximately a four foot layer every second day, until it is full, when the top should be

covered by straw and then by a heavy coating of soil so that neither rain nor air can gain entry.

Molasses is added so that the desirable types of bacteria are encouraged and to enable them to keep in check the type which act adversely on protein and cause putrefaction. Care in proper consolidation is essential as, if air is not excluded from the silo, the temperature becomes too high and the final product is dark brown in colour and much of the dry matter is lost. On the other hand, if the contents are too cold, the material putrefies and will be rejected by stock. Too low a temperature results from the crop being wet at the time of loading or from filling the silo too quickly. When feeding silage, only the day's supply should be extracted and the excavation re-covered.

First quality silage made from young leafy grass is the best type for replacing concentrates. It should be fed at the rate of 20 lbs. per gallon, though of samples of a very low water content, 16 lbs. will suffice. Silage should only be fed for yields up to 3 gallons, production in excess of this being met by a concentrate mixture. Thus a cow giving 5 gallons daily would receive 60 lbs. silage and 7—8 lbs. concentrates though up to 150 lbs has been given.

Silage made from arable crops or grasses which have flowered should be used in the maintenance ration. Ensiled kale has been shown by Scottish experience to improve the milk flow and should be treated as arable silage. Molasses is not necessary in making this type. (For further information on the use and testing of silage see Ministry of Agriculture Bulletin No. 50.)

Calculating Production Rations

When designing rations to be fed at 4 lbs. per gallon, 100 lbs. of the mixture should contain approximately 65 lbs. SE and 13 lbs. PE. To include sufficient nutrients in 3½ lbs., 100 lbs. should contain about 71 lbs. and 15 lbs. respectively. An extra ½ lb. of these mixtures should be fed to Channel Island breeds and other cows giving 4.5% to 5% butter fat.

Suitable production rations are:—

Rations for Milk Production

Group 1—4 lbs. per gallon

1 part Oats
1 part Beans
4 lbs.— .54 lbs PE, 2 50 lbs. SE

1 part Oats
1 part Peas
1 part Weatings
½ part Bran
½ part Palm Kernel Cake
4 lbs.— .50 lbs PE, 2.62 lbs. SE

1 part Maize
2 parts Oats
½ part Soya Bean Meal
½ part Linseed Meal
4 lbs — .52 lbs. PE, 2.54 lbs. SE

Group 2 —3½ lbs. per gallon

4 parts Oats
6 parts Beans
3½ lbs.— .53 lbs. PE, 2 52 lbs SE

4 parts Oats
4 parts Beans
2 parts Linseed Cake
3½ lbs.— .54 lbs. PE, 2.31 lbs. SE

1 part Oats
1 part Flaked Maize
1 part Linseed Cake
½ part Decorticated Ground Nut Cake
3½ lbs.— .53 lbs. PE, 2.52 lbs. SF

1 part Dried Brewers' Grains
2 parts Flaked Maize
½ part Fish Meal
3½ lbs.— .52 lbs. PE, 2.32 lbs SE

*1 part Wheat
1 part Linseed Cake
1 part Coconut Cake
½ part Palm Kernel Cake
3½ lbs.— .50 lbs. PE. 2.61 lbs. SE

½ part Maize Gluten Feed
2 parts Dried Sugar Beet Pulp
1 part Wheat
1 part Flaked Maize
½ part Fish Meal
3½ lbs.— .50 lbs. PE. 2.40 lbs. SE

* This ration is not readily accepted until the cows become used to it. Introduced gradually, it is successful.

Group 3.—Rations from Grass

4 lbs. Dried Grass
20 lbs. Grass Silage
16 lbs. Grass Silage. (If moisture content low)

Combined Maintenance and Production Rations for Limited Yields

Where cows give only 2 or 3 gallons daily, and where abundant home grown foods are available, it is profitable to feed rations from such foods to cover maintenance and all production.

The following are suggested for this purpose:—

For cows of 1,000 lbs. liveweight producing 2 gallons daily.

	DM lbs.	PE lbs.	SE lbs.
10 lbs. Medium Hay	8.57	.46	3.86
5 lbs. Lucerne Hay	4.20	.51	1.78
20 lbs. Potatoes	4.56	.16	3.70
30 lbs. Marrow Stem Kale	1.20	.42	2.73
1 lb. Oats	.84	.08	.59
	22.37	1.63	12.66

	DM lbs.	PE lbs.	SE lbs.
40 lbs. Mangolds	4.88	.16	2.52
10 lbs. Oat and Tare Hay	8.40	.54	3.58
6 lbs. Medium Hay	5.14	.28	2.32
5 lbs. Dried Brewers' Grains	4.49	.63	2.42
	22.91	1.61	10.84

	DM lbs.	PE lbs.	SE lbs.
20 lbs. Medium Hay	17.14	.92	7.72
50 lbs. Marrow Stem Kale	7.00	.70	4.55
	24.14	1.62	12.27

For cows of 1,250 lbs. liveweight producing 3 gallons daily.

	DM lbs.	PE lbs.	SE lbs.
20 lbs. Sugar Beet Tops	3.24	.24	1.72
15 lbs. Medium Hay	12.80	.69	5.79
50 lbs. Marrow Stem Kale	7.00	.70	4.55
10 lbs. Oat and Tare Hay	8.40	.54	3.58
	31.44	2 17	15.64

	DM lbs.	PE lbs.	SE lbs.
10 lbs. Medium Hay	8.59	.46	3.86
10 lbs. Lucerne Hay	8.40	1.01	3.56
20 lbs. Arable Silage	6.92	.56	2.60
20 lbs. Potatoes	4.70	.16	3.70
20 lbs. Swedes	2.30	.14	1.46
	30 91	2.33	15.18

	DM lbs.	PE lbs.	SE lbs.
10 lbs. Oat and Tare Hay	8.40	.54	3.58
10 lbs. Medium Hay	8.57	.46	3.86
50 lbs. Cabbage (Open)	7.65	.75	4.95
,5 lbs. Dried Brewers' Grains	4.47	.63	2.41
	29.09	2.38	14.80

Feeding for High Yields

Feeding of high yielding cows, producing 6 gallons and upwards per day, involves special consideration. For a yield of, say, 8 gallons of average quality milk, the cow must have 28 lbs. of concentrates or 24.5 lbs. dry matter, leaving room for only 6 lbs. dry matter for maintenance, if the total ration is to be kept within the 30 lbs. limit for an animal of 1,000 lbs. If the maintenance ration were met by 7 lbs. best quality hay (approximately 6 lbs. DM) it would provide only 3.23 lbs. SE and .54 lbs. PE against the cow's theoretical requirements of 6 lbs. and .6 lbs. respectively. (It is considered that 6 lbs. hay is the minimum roughage a cow should receive.)

It has been shown in Chapter VII that 1 gallon of milk contains 1.75 lbs. SE and .35 lbs. PE, while 2.5 lbs. SE and .5 lbs. PE are allowed in the ration. Similarly, the maintenance ration of 6 lbs. SE and .6 lbs. PE are generous allowances. Obviously, a cow producing 8 gallons converts her food efficiently, and probably does not require the margin of nutrients allowed in the Feeding Standards. Also, high yielders can usually eat some excess of dry matter over the normal limit of 30 lbs., and by a combination of these factors, provided feeding is carefully planned, they can provide for maintenance and high yields.

A suitable scheme, keeping the dry matter within 30 lbs. is shown below:—

Gallons per day	Maintenance Best Hay or Equivalent	Nutrients Contained in Maintenance Ration		Concentrates 3½ lbs. per gallon	Total Dry Matter of Ration
	lbs.	PE	SE	lbs	lbs.
6	14	1.08	6.47	21	30.17
7	10	.78	4.62	24½	29.92
8	7	.54	3.23	28	30.26

This scheme is based on that suggested by Professor Boutflour some years ago.

If the nutrients necessary for 1 gallon milk are included in 3 lbs. of a concentrate mixture, the problem becomes less acute, and the following plan would answer:—

Gallons per day	Maintenance Best Swedes or Hay	Equi-valent	Nutrients Contained in Maintenance Ration PE	SE	Concentrates 3 lbs. per gallon	Total Dry Matter of Ration
	lbs.	lbs.	lbs.	lbs.	lbs	lbs
6	12	40	1 21	8 46	18	30.16
7	10	30	99	6.81	21	29 91
8	7	35	.79	6 19	24	30.51

For larger cows of 1,100—1,250 lbs. liveweight, feeding for high yields is easier, as the capacity for food is greater. A 1,250 lbs. cow can deal with about 35 lbs. dry matter.

Every assistance should be given to such cows by offering only the best quality and most easily digested foods. Bran, flaked maize, wearings and dried sugar beet pulp (soaked in water) are suitable for inclusion.

As an example of the efficient use of foods by cows and thus producing on less than the normal allowance of nutrients, A. H. Cobbald, writing in *Agriculture*—July, 1944, gives his production ration as 4 lbs. oats and beans mixed at the rate of 2 parts oats to 1 part beans. 4 lbs of this mixture gives:—

	PE lbs.	SE lbs.
2⅔ lbs. Oats	.19	1.58
1⅓ lbs. Beans	.26	87
	.45	2 45

The degree of success with which Mr. Cobbald's animals use this ration is demonstrated by the fact that, at the time of writing, his herd heads the list of production averages for their breed.

It is imperative that high yielders be fed as individuals. To facilitate this, they should be kept together in one part of the byre and milked three times daily.

Suitable rations for cows producing upwards of 6 gallons are shown below:—

½ part Locust Beans
½ part Soya Bean Meal
1 part Decorticated Ground Nut Cake
1 part Linseed Cake
2 parts Flaked Maize

2 parts Oats
1 part Bran
½ part Fish Meal
3 lbs.— .55 lbs PF, 2.10 lbs. SE

1 part Wheat
1 part Maize Gluten Feed
2 parts Barley
1 part Oats
1 part Cotton Seed Meal
1 part Decorticated Ground Nut Cake
1 part Coconut Cake
2 parts Flaked Maize
3 lbs.— .49 lbs. PE, 2.22 lbs. SE

2 parts Flaked Maize
1 part Dried Sugar Beet Pulp
1 part Weatings
1 part Beans
1 part Decorticated Ground Nut Cake
1 part Barley
1 part Linseed Meal
1 part Palm Kernel Cake
3 lbs.— lbs. PE, 2.20 lbs. SE

Home Mixed and Purchased Foods

Owing to the difficulty of ensuring proper distribution, many farmers buy their concentrates ready mixed. These proprietary mixtures are usually designed so that 3½ lbs. are sufficient for 1 gallon of average quality milk (4 lbs. for Channel Island Breeds), and if bought from a reputable firm, there is no doubt as to their efficiency. Owing to the saving of labour which would be required for the mixing of straight meals, these compounds are worth the few shillings extra per ton charged. They have other advantages in that the feed is usually cubed. These cubes are bound by molasses and are usually palatable. Each cube is properly balanced and waste by spilling at feed times is minimised. Many suppliers employ experts who will advise on how to use the available home grown foods in conjunction with their products.

In normal times, when an astute farmer may be able to buy "ahead" at profitable rates, straight foods are, of course, justified. These opportunities are open mainly to the larger farmers who can deal in big quantities.

It is obviously wrong to add other foods to a balanced ration, unless the additional food or combination of foods in itself contains the correct balance of PE/SE 1/5. Thus bran, or equal parts of oats and beans or any other balanced single food or combination may be added. However, as oats are widely grown in this country, special mixtures have been put on the market which give a ration balanced for production when oats are added: These are:—

National Grain Balancer, to be fed with equal parts oats.

National High Protein Concentrate—1 part concentrate to 3 parts oats.

It is important that concentrates, accurately weighed, be fed to each cow individually according to her yield. To do this, a slate or board should be placed at the head of each cow's stall giving her daily yield and the amount of concentrates she is to receive. A bowl or pan with a handle capable of holding only $3\frac{1}{2}$ lbs. (or 3 lbs. or 4 lbs. as the case may be) should be used as the measure, and if the food requirements are stated on the board in terms of this measure, the job is simplified.

Routine of Feeding

Regularity is an important factor in feeding. Cows should be fed three times daily, commencing with half the concentrate ration immediately before the morning milking. The other half should be given prior to the afternoon milking. Roots, silage and any other foods which may taint milk must be fed after milking, and also in the middle of the day, when some hours must elapse before milking is again due. If straw is included, it should follow succulents, as cows may refuse to eat it after a dry feed. Straw and hay must not be fed immediately before milking as the dust raised contaminates the milk pails. For the higher yielders, concentrates should be divided over three feeds and be given before the bulky

foods. A final feed of hay after the evening milking completes the day.

Summer Feeding

Grass is the most variable of all crops and even neighbouring fields may be dissimilar in the content of nutrients.

The following are the chief factors influencing the feeding value of pasture:—

Amount and balance of plant nutrients contained in the soil.

Plant types included in the flora

Age of Pasture.

Methods of Management.

Season.

Weather, particularly temperature and rainfall.

Because of this variability, each field must be judged on its merits and, besides analysis, observation and experience are the only guides. It is impossible to go into every circumstance which a farmer may meet, and the treatment of only a specimen example can be given here. It is hoped that this will fit somewhere near the majority of cases, and will explain the principles of grassland utilisation.

Average pasture in spring contains the following nutrients per 100 lbs.

DM	PE	SE
lbs.	lbs.	lbs.
20	2.1	11.2

A cow of average size is reckoned to be capable of eating 150 lbs. of grass per day, so that, in terms of nutrients, she will consume 30 lbs. dry matter, 16.8 lbs. SE and 3.2 lbs. PE. As the cow requires 6 lbs. SE and .6 lbs. PE for her own maintenance, she has a surplus of 10.8 lbs. SE and 2.6 lbs. PE for milk production, which would appear to provide sufficient SE for 4 gallons and PE for 5 gallons. However, in the energy expended on grazing, she may use 1½ lbs. SE*, leaving a surplus to cover only 3½ gallons. The feed is thus badly balanced in that she has SE for 3½ gallons and PE for 5 gallons

The smaller of these quantities is the limiting factor and such grass will provide only for yields up to 3½ gallons. For a 5 gallon yield, the cow must be provided with sufficient SE for a further 1½ gallons. This requirement can be met by a carbohydrate concentrate such as oats (6 lbs.), maize (4½ lbs.), or flaked maize (4 lbs.). For production beyond 5 gallons a full concentrate ration must be fed for each gallon in excess of that figure.

Some cows are content to feed placidly on the plants nearest them, while others are restless and selective and roam the pasture seeking the most tasty foods. However, as the tendency is for the herd to move together, the quieter following the discontented, the figure given above to cover energy losses may be taken as average for good pasture.

As the grazing season advances and the value of grass declines, it is important that the yields of cows be watched daily and adequate feeding introduced to counteract the first sign of a drop. Should a serious reduction occur, it is very difficult, if not impossible, to restore the flow.

When the spring flush passes, the protein content of grass falls away, and by early July, average pasture may be balanced for maintenance and 2 gallons, so that all animals producing over that quantity must be fed a full production ration for each additional gallon. Later in the year, the grazing value diminishes further until only maintenance needs are covered, while in a very dry season, average pasture may be valueless. In this event, fodder and succulents should be thrown down for maintenance.

Management of Pasture for Maximum Yields

Careful management assists in building up and lengthening the seasonal life of nutritious pastures. Young, leafy and quick growing grass is richest, and to encourage rapid growth (provided all other necessary plant foods, and particularly lime and phosphates with the addition of potash for light land are present in the soil) a nitrogenous dressing should be given early in March. 1—1½ cwts. Nitro-Chalk per acre is probably the most effective and the dressing should be repeated towards the end of the summer to lengthen the productive season. Despite quite

widespread belief to the contrary, this treatment will not depress the clovers present. The fertiliser should be sown in wet spells and is more effective in seasons of adequate rainfall.

It must not be thought, however, that repeated applications would still further add to the value of the grazing. If this were done, say, at fortnightly intervals, the proteins would not have time to develop and would be in the form of amides, or "raw" proteins. The result of such treatment would be shown by severe scouring in the stock and a reduction in yields. Over-frequent application would also upset the balance of other plant foods and exhaust the soil.

A further point of management is based on the knowledge that continuous grazing on one field is harmful to the flora and leads to rapidly diminished value. The available grazing should be divided into as many fields as is practicable, and each field in turn grazed heavily—say five or even ten cows to the acre—until the herbage is eaten down. When the last field is bared, the rotation begins again with the first field strong and leafy, and in this way, a much greater gallonage per acre will be obtained than if only one large field is constantly grazed.

The disadvantages of this system are the difficulty of providing drinking water to each field and the cost of fencing. The latter is considerably reduced by the use of electric fencing, which is much respected by cattle. The exercise of ingenuity will usually overcome the water difficulty, which is really a separate problem for every farm.

Should growth get ahead of the stock, then the grass should be cut before it reaches the flowering stage or, if it will not suffer by the additional treading, stores should be put on to eat it down.

In spring, particularly on young swards and in a mild, wet season, the flush of protein rich grass (it may reach 5% or even 6% protein in these circumstances) brings the risk of scouring. To prevent this, cows should be turned out for only a short period each day, the time being gradually increased as the digestive systems become accustomed to the conditions, until in a week or two they are out all day. An alternative and better arrangement is to allow them on to good young pasture for periods up to an hour twice daily and keeping them on poorer

fields for the rest of the day. This arrangement should be continued as long as the grass is in rapid growth. With careful watch on yields, this system, coupled with rotational grazing as described above, may be retained well into the grazing season, thus extending the usefulness of the better grass.

Other methods of countering laxative effect are to give the cows a small feed of hay or other fibrous material before going out, while manufacturers of compounds offer costive concentrates of a high starch equivalent.

At the latter end of the season, hay foggage provides a good boost to yields. It should be handled in the same way as spring grass and the simpler treatment is to put the cows on for an hour twice a day and then return them to their regular pastures which provide, so late in the season, maintenance only.

In the early part of the season, close grazed rotational pasture has been found to suffice for 5 gallons production, without the need for other foods. That is, however, about the limit yield which may be expected from grass, as cows cannot eat sufficient to cover greater production.

Grazing cows normally receive all the vitamins they require, and unless the ground is deficient in calcium and phosphates, mineral supplies should also be ample. However, it is always safer to have mineral licks, or mixed minerals in a trough, available to stock, and particularly when high yielders are considered.

Dry cows and calving heifers require no feeding beyond average pasture and should be kept out of rich fields. Should, however, the grass be very poor, some concentrates must be given. At all times of the year, these animals should be regarded as milking cows, so that individual attention is given them.

Provided she is bred for the job, it may be said that the more a cow can be induced to eat, the more milk she will produce. She will, naturally, eat more of a tasty food than of one which she dislikes. Moreover, so far as grassland products, straw, roots, and other home grown foods are concerned, the more palatable specimens are those which contain the highest rate of nutrients. It follows, then, that not only will a cow eat more of a given food if she likes it, but she will also produce more milk for each unit of such food consumed. The advantage of offering

palatable food is therefore two sided, and the farmer can do much by proper treatment of the land and crops, and by grazing and harvesting at the right time, to improve the milk yield from his acreage.

If the daily ration is spread over four feeds, a cow will eat considerably more food than when only two feeds are given, she will consequently yield more milk. This is another of the schemes often adopted by those pushing cows for high yields.

Water. Experimentally, it has been found that fattening bullocks drink 1 gallon of water per cwt. of liveweight daily, and it must be assumed that cows require similar quantities. Moreover, each gallon of milk contains almost .9 gallon of water, so that a cow of 1,000 lbs. (9 cwts.) producing 4 gallons of milk must have at least 13 gallons of water and possibly 20 gallons. These quantities are not, of course, required in full by stock at grass or receiving succulents, when the quantity of water taken will fall by approximately the amount contained in the food.

Water should be placed conveniently for the cows' use, as it has been shown that, if obtaining it involves any effort, cows will drink much less than if it is readily available. For housed stock, automatic drinking bowls are best, as cows can then take as much as they require. If cows have to be turned out in winter to drink, their opportunities are curtailed and chills may result from this practice if the weather is particularly inclement. Similarly, carrying water to the troughs places a restriction upon the cows and is costly in labour.

For animals running outside, water troughs served by a continuous flow, should be installed in the fields. To permit cows to drink from burns or ditches involves the risk of infection, while the use of stagnant pools is an invitation to trouble which will in all likelihood be accepted.

Before a farm can be licensed for T.T. milk production, all streams must be fenced against the stock and running water must be laid on as suggested above.

CHAPTER XI

THE FEEDING OF NON-MILKING ANIMALS FOR BEEF

SOME knowledge of the beef market is necessary if the farmer is to get the best return from cast animals. The following are the classes of stock which fall for disposal through this channel:—

Bull calves for veal.
Sterile heifers.
Heifers proving to be poor milkers
Cows prematurely removed from the herd because of udder trouble, poor milk yield, etc.
Aged cows
Sterile bulls.
Bulls whose daughters are ready for breeding. Farmers who carry only one bull must replace him at this stage and, unless he is very well bred, he is unlikely to find a sale for further breeding.
Aged bulls.

THE MARKETING OF BEEF ANIMALS

Before the war, fat stock was sold by auction, but the system now is to consign the animals to a grading centre. There they are weighed and graders assess by sight and touch the proportion of carcase weight to liveweight. The gradings and prices are published regularly in the agricultural press.

Each class of animal is graded separately, the classes being for fat cows; home bred steers and heifers; home bred cow heifers; fat bulls; and imported steers and heifers. Below is a specimen grading chart, the prices given being those for November, 1948:—

Class.	*Home Bred Steers and Heifers.*				
Grade and killing out percentage	Super Special 59% and over	Special 58%	A+ 57%	A 56%	A– 55%
Price per live cwt.	104/9	102/9	100/6	99/-	97/6
		B+	B	B–	C+	C
		54%	53%	52%	51%	50%
„		95/9	93/-	90/-	70/-	67/-

As a comparison, the prices for Grade A for the other classes at that date were:—

Fat cows	61/6 per live cwt.
Home bred cow heifers	99/- per live cwt.
Fat bulls	57/6 per live cwt
Imported steers and heifers	54/6 per live cwt.

Animals are given low gradings when they are lightly fleshed, show hollows over the rump, or are too fat. The Super Special grade applies only to steers between 9 cwt. and 13½ cwt. net liveweight and to heifers of 8 cwt. to 12½ cwt., while bonuses are payable for somewhat similar weights in other classes.

Prices also vary seasonally. They rise steadily from January to June and fall again to December. To catch the highest prices is an obvious advantage and all information on the subject should be carefully read.

Housing and management. Feeding cattle should be run loose in courts or boxes, as chained animals cannot continue long on heavy feeding. If housed, lighting should be restricted, as the more subdued conditions of a half light induces animals to take more rest. Trough space should be ample as, if milling for food occurs, a substantial portion of the ration is used in the energy expended.

The temperature of houses should be between 60° F. and 70° F., and to prevent sweating, the thick hair along the spine should be clipped.

Food Requirements of Fattening Cattle

Starch is the principal food factor in fattening, so that wider PE/SE rations and cheaper rations may be employed. The dairy farmer is not concerned with the further growth of animals to be fattened, his main object being to get a reasonable grading at low cost and to get the beasts off his hands as quickly as possible. For that reason, it is unnecessary to apply the feeding standards meticulously, and for practical purposes, a feeding plan may be summarised thus:—

Cattle of 2—2½ years—good condition.

Liveweight	7 cwts.	8 cwts.	9 cwts.
SE required daily for maintenance	5 lbs.	5½ lbs.	6 lbs.
SE required for 2 lbs. liveweight increase daily	5 lbs.	5 lbs.	5 lbs.

Old cows and bulls—poor condition.

Liveweight	9 cwts.	10 cwts.	11 cwts.
SE required daily for maintenance	6 lbs.	6½ lbs.	7 lbs.
SE required for daily gain of 2 lbs. at beginning of fattening	5½ lbs.	5½ lbs.	5½ lbs.
SE required for daily gains of 2 lbs. at end of fattening period	8 lbs.	8 lbs.	8 lbs.

Total PE requirement in all cases—1.5 lbs.

The rations should be made up as far as possible from home grown foods. The usual bulky foods are given and concentrate mixtures should comprise 3 to 4 parts carbohydrate concentrates to 1 part high protein cake or meal such as fish meal or cottonseed meal or cake. If fish meal is given, it should be withdrawn in the final two weeks of fattening, as the flesh may be tainted. It is not necessary at this late stage to replace the protein lost from the ration.

The rations used depend upon the crops available on the farm. On arable holdings, large quantities of straw and roots (up to 1 cwt. daily) are sometimes offered. Roots may be replaced by potatoes up to 50 lbs., but in this event, extra protein must be included in the concentrates, as potatoes are very starchy. Kale is as good as roots.

Although a ration containing the correct amounts of

nutrients can be made up entirely from fodder and roots, rations of this type are not so efficient in practice as those containing concentrates. This is because a greater proportion of the food is used in mastication and digestion, and for rapid fattening, straw should be replaced by hay, roots kept within a limit of 50 lbs., and the proportion of concentrates increased.

The art of feeding for high grades is in knowing when the animal is ready for killing. Feeding beyond that stage may lower the grading. Experience and an "eye for a beast" are the only guides on this point.

When beef cattle were sold by auction, it was customary to feed linseed cake or meal, as the gloss imparted to the coat suggested better condition and attracted a higher price. Graders are not so susceptible to appearances, but it may be said that many animals go before them bearing an unnecessarily rough appearance. While expensive feeding of oil cakes is meantime of no advantage, the animals should be presented in as good order as is possible.

Although many farmers would prefer to be paid on carcase weights, the graders are remarkably accurate in their estimates, and it is unlikely that any farmer suffers by the system.

The Feeding of Fattening Cattle

Veal. Bull calves of Ayrshire and Channel Island breeds are not worth feeding. They are usually sent to the first weekly market following their birth and are only a few days old when killed for potted veal. The price obtained is often less than 20/-.

Dual-purpose calves, and particularly Friesians, may be fed for veal. This trade demands a white fleshed carcase of about 8—10 weeks, best secured by generous feeding on whole milk. Milk should be increased from 1 gallon at birth to 3 gallons daily at the finish.

Calves should make liveweight gains of 2 lbs. daily and so should reach suitable marketing weight (approximately 200 lbs.) in 8 weeks. About 1 lb. liveweight gain may be expected from each gallon of milk fed.

There is little demand for veal in Britain, and so long as milk is in short supply, there seems no justification for

its production. When milk prices were very poor, a better return was often secured by conversion to veal.

Heifers. Heifers sent for fattening because of sterility or low milk production should be in good condition, as previous feeding and management have been directed towards preparing them for calving and lactation. If they are not sufficiently fat for killing at once, they should be kept on a good dairy maintenance ration, such as those recommended in Chapter X for cows producing 5—6 gallons, plus about 5 lbs. concentrates. Suitable concentrates are:—

4 lbs. Oats
1 lb. Fish Meal

2 lbs. Oats
2 lbs. Dried Sugar Beet Pulp
1 lb. Decorticated Ground Nut Cake

This arrangement approximates very closely to the recognised feeding standards.

Mature cows. If it has been decided that a cow is on her last lactation, she should be fed so that she is fat, or almost fat, when she dries off. This was the system adopted in the old town dairies.

As the yield begins to fall, she should be given 3 or 4 lbs. concentrates (more if necessary) in excess of production requirements. The excess may be supplied from ordinary milk production rations or from those suggested for fattening heifers.

Should the condition be very low when it is decided to fatten her, she must be put on to beef rations, specimens of which are given below:—

Rations for early stages of fattening of 10 cwt. cow *in poor condition*

15 lbs. Oat or Barley Straw
5 lbs. Medium Hay
30 lbs. Arable Silage or 60 lbs. Swedes
3 lbs. Cereals—Oats, Maize, Wheat, Barley, etc.
1 lb. Fish Meal, Decorticated Ground Nut Cake or Meat Meal or 2 lbs. Linseed Cake

	DM	PE	SE
This ration gives approximately	29 lbs.	1.7 lbs.	12 lbs.

Rations for fattening 10 cwts. cow, to be introduced *when she reaches "fresh" to half-fat condition*

8 lbs. Medium Hay
5 lbs. Oat or Barley Straw
40 lbs. Swedes or 20 lbs. Arable Silage
25 lbs. Potatoes
4 lbs. Dried Sugar Beet Pulp or Cereals
1 lb. Fish Meal, Meat and Bone Meal or 1½ lbs. Soya Bean Meal

	DM	PE	SE
Approximately	28 lbs.	1.6 lbs.	14—15 lbs.

When feeding these rations, straw may be given ad lib. If in courts or loose boxes, any excess will be tramped into dung.

Bulls. These should be fed in the same way as females of similar age and condition.

Summer Fattening

Good pasture in early summer is sufficient for liveweight gains of about ¾ lbs. daily. Satisfactory returns for cast dairy stock can therefore be secured if the animals are in fair condition when the grass comes on in early spring. A few weeks grazing brings them into top condition for the high priced market.

One acre of good grass suffices for one fattening animal.

If grazing cattle are not "finished" by the beginning of August, concentrate supplements may be required.

Water

Adequate water is essential for fattening stock. The cattle should have free access to drinking bowls or troughs supplied by running water.

Note. Heifers and cows of the dairy breeds destined for slaughter are usually sent to the grading centre or

knackery without any attempt being made to fatten them, as this cannot be done profitably.

Further reading—Chapters VII to XI.

The Principles and Practice of Feeding Farm Animals—by E. T. Halnan and Frank H. Garner, Longmans Green & Co.

Rations For Livestock, Bulletin No. 48, The Ministry of Agriculture and Fisheries—by H. E. Woodman.

The Plough up Policy and Ley Farming—by R. G. Stapledon, Faber and Faber, Ltd.

Silos and Silage—by H. I. Moore, The Farmer and Stockbreeder.

CHAPTER XII

MANAGEMENT OF THE MILK HERD

MANAGEMENT is a vital factor in the success of dairy farming, and shares with breeding and feeding the responsibility for results achieved. It is the varying degrees of efficiency in each of these spheres, equally, which accounts for the wide differences in costs per gallon of milk produced which are invariably found when economic surveys of groups of farms are made. Frequently, the costs on some farms are found to be fully double those of neighbouring establishments.

The importance of management may be stressed by saying that cases have been recorded in which the employment of a new cowman, working with the same stock and foods as his predecessor and with no advantages other than his personality, has raised the average yield of a herd by 200 gallons in a single year.

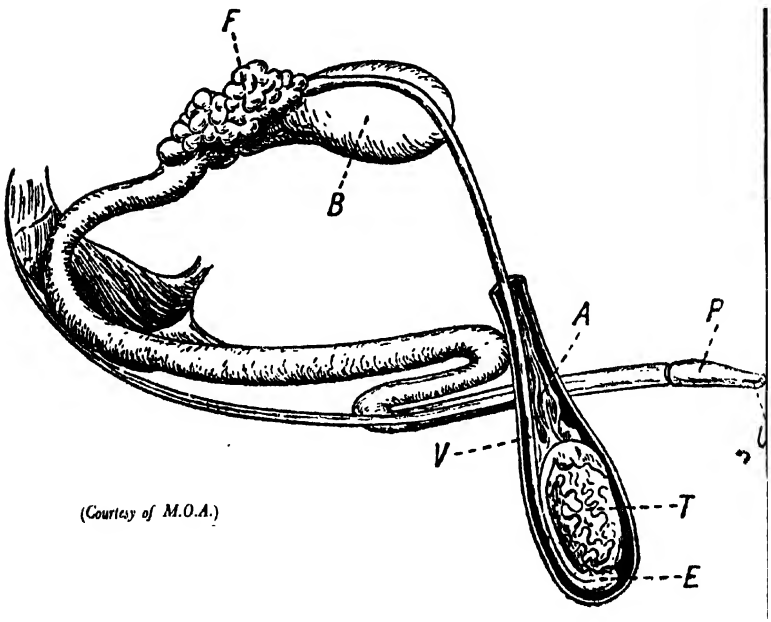
Management may be conveniently divided into four divisions—the mating and fertility of stock, points which influence the yield and quality of milk, and general management. In order that these subjects may stand out clearly and be available for easy reference, each one is treated in the following pages as a separate section.

THE SEX CYCLE, MATING, AND FERTILITY

Failure to breed is a major cause of loss to dairy farmers and accounts for almost 25% of herd wastages, besides the loss of milk resulting from delayed calvings. In the following pages, a description of the process of conception and birth, and factors which may interfere with the normal workings of these functions, is given.

The principal organs of sex are the testicles of the male and the ovaries of the female. In these parts, the process

of reproduction begins, and under their influence, the secondary sex characters emanate. Thus, the secretions of the testicles produce the thicker neck, broader head and the various characters typical to the male, while in the female, more gentle temperament and finer body construction are evident. These character differences become more marked after puberty.



(*Courtesy of M.O.A.*)

REPRODUCTIVE ORGANS OF A BULL.

A—Blood vessels in scrotal cord supplying testis.
T—Testis—forms spermatozoa.
E—Epididymis—stores spermatozoa.
V—Vas deferens—conducts spermatozoa in ejaculation.
F—Vesicula seminalis—supplies fluids diluting spermatozoa on ejaculation.
P—Penis—intromittent organ.
U—Opening of urethra—conducts semen and also urine from bladder.
B—Bladder—stores urine.

The testicles of the bull are oval shaped glands contained within the scrotum. Along the posterior border and reaching some way over the top and bottom of each testicle is a long, coiled tube, the Epididymis.

The testicles contain many coiled tubes (seminiferous tubules) which combine in groups to join the efferent ducts as they leave the testicle at the top. There they enter the head of the epididymis. This tube is closely coiled as it follows the posterior line of the testicle to culminate in the tail, where it merges into the ductus deferens. The ductus deferens passes out of the scrotum into the body cavity and joins the urinary tract at the bladder. From there, it continues to the penis.

Sperm are produced in the seminiferous tubules and, together with fluid which is secreted in small amounts, enter the epididymis at the head and travel slowly to the tail. During this stage, which may be described as a short period of storage, the sperms mature and increase their viability.

The one weakness of the male (in most species) is that such important glands are placed outside the body and are almost unprotected. The purpose is to keep the sperm cool, as at body heat they are greatly activated and quickly exhaust themselves. In the fœtus, the testicles are formed and retained within the body and do not descend until after birth. It is interesting to note that the testicles of some species remain in the abdomen while in others they enter the scrotum at the beginning of the breeding season and are retracted when the season is over.

When copulation takes place, the stored sperms pass from the tail of the epididymis to the ductus deferens and the fluid which surrounds them is diluted by accessory fluids produced by the seminal vesicles and prostate glands. While the function of the fluids is not completely known, they appear to increase the activity of the sperms as well as acting as a means of suspension. It has also been suggested that they clear the urethra of secretions which may be injurious to the sperms. The complete fluid, semen, is then carried to the penis by muscular contractions and ejected with some force into the vagina and the mouth of the womb.

While the males of most species of farm animals will mate at any time, females only do so at certain periods. In many species, as with the ewe and, to some extent, the mare, mating and, of course, conception, can take place only at fixed seasons, whereas in the cow and sow, the cycle recurs throughout the year.

The ovaries of the female, of which there are two, correspond to the male testicles. These are placed near the ends of the Fallopian or egg tubes which join the womb at the horns. The other end of the womb is guarded by the cervix. From the region of the cervix, the vaginal passage runs to terminate in the vulva, which is the external and visible part of the female genital system.

The ovaries contain the Graafian Follicles in which the eggs grow and ripen. Under the influence of pituitary secretions which stimulate them to develop and produce a fluid, the follicles work towards the surface of the ovary. The follicles secrete the hormone œstrin, and when this enters the blood stream, heat occurs and mating becomes desirable. The most advanced follicle reaches the surface of the ovary, and a day after heat has passed, the skin of the ovary is burst by the accumulation of fluid and the egg is forced out of the follicle.

The egg then enters the funnel shaped end of the Fallopian tube, which becomes turgid and is thought to embrace the egg as it is shed. The egg passes down the tube. Various secretions which lubricate the entire genital system are produced and the vagina enlarges to permit entry by the male. Fluid of an acid nature is secreted by the walls of the vagina.

The male sperms, shaped like tadpoles and with similar ability to swim, proceed through these female juices into the egg tubes and in a successful mating (as described in Chapter IV), one wins access to the egg and fertilises it. Fertilisation is usually accomplished in the topmost third of the egg tube, and as the sperms take several hours to reach that point, they require a day's start of the egg. The shedding of the egg a day after heat has passed permits of this, and as cow heats are of relatively short duration, there is little danger of the sperm dying before they meet the egg as may happen with mares and sows, in which the heat period is much longer.

On its journey down the tube, the fertilised egg divides to form cells and the sequence which is continued throughout the new animal's life, is begun. In about five days, the egg reaches a horn of the womb where it grows into the embryo and then the fœtus, and is finally discharged as a fully developed young animal. In the cow, this gestation process takes about 280 days or nine months.

After the egg has been shed from the ovary, a yellow coloured tissue (Corpus Luteum) forms in the vacated follicle and produces a hormone, progestin, which prepares the womb for the reception of the fertilised egg. The corpus luteum preserves the integrity of the ovary by remaining in position throughout pregnancy and thus preventing the ripening of further eggs and heat periods. Progestin also promotes, at a later stage, the alveolar development within the udder. But, should the cast out egg which preceded its formation escape fertilisation, the corpus luteum gives way to permit the re-commencement of the whole cycle. In cows, the cycle takes about 42 days and as the ovaries normally function alternately, 21 days is the usual period which elapses between each heat. There may be variation of a few days either way in individuals.

The duration of heat is variable, being as short as six hours in winter, while in summer a cow may remain in season for 30 hours or even more. The average period is about 20 hours.

Heat is betrayed by a swelling of the vulva, restlessness, and, if the cow is loose amongst others, they pay her a good deal of attention and may jump her. In some cows signs of heat are scarcely noticeable. Close watch must be kept when it is desired to mate an animal, particularly if she is kept tied up and apart from the bull in winter. A short period may occur in the night and so pass unnoticed.

In some cows, and more frequently in heifers, a whiteish, and possibly blood stained discharge, resulting from changes in the tract, appear in the vulva two or three days after heat has passed. This provides a good guide to the date of the next period, which should occur within 17—20 days.

Although the chances of conception are highest if cows are mated in the first heat after calving, it is best to

delay service for three months so that they calve again about the same time in the following year. While cows come on heat every three weeks, the natural calving season appears to be the spring and it is, in practice, difficult to keep to a programme which disperses calvings throughout the year. The condition of animals, particularly of the females, is never stationary. After calving, vitality is low and picks up again when the peak of the lactation is past. It is important that a cow due to be mated three months after her previous calf is born, be built up quickly to this point so that she is in the desirable "rising" condition when mated. It is in this condition she is most likely to conceive.

Similarly with heifers. If they have been running on poor pasture, they should be put on to better feeding a month or so before mating, so that vitality is increasing at the time of service.

Matings are presumed to be fertile if no further heat takes place, but, owing to the very slow early growth of the fœtus, positive farm diagnosis is not possible until the fourth or fifth months. At that stage, if a heifer is "milked" a sticky fluid may be drawn from the teats, while cows in milk usually show a drop in yield. The calf may be felt at approximately six months by pressing the right flank.

Earlier tests can be made by vets. who, by examination via the rectum, can usually tell if pregnancy exists by the end of the second month. Much time and production can be lost by animals presumed to be in calf when, in fact, they are not, and such losses may be saved by regular veterinary checks.

Cows' urine does not react to pregnancy tests as does that of other species.

Causes of Sterility in Bulls

Failure to effect conception, usually referred to as sterility, may be a temporary or permanent fault and may lie with either the cow or the bull.

Several factors influence the rate of live sperm which is produced and ejaculated, and the bull's ability to mate.

As has been stated, sperms, after production in the

seminiferous tubules are retained, awaiting use, in the epididymis. These sperms break down and die if they are allowed to remain too long in the system and their presence tends to reduce production of fresh sperms. Matings at wide intervals are therefore liable to be infertile and bulls should be used regularly rather than given long spells of idleness.

Overwork is equally bad. If the bull is used too frequently, the quantities of both semen and sperm which are ejaculated fall sharply and the sperms are of low vitality. This latter point appears to be caused by their being in the epididymis for too short a period to allow of full development. With rest, recovery is rapid in a healthy animal and normal powers are regained within a few days.

The condition of the bull may also give rise to a state of low fertility. In one allowed to become fat, the functions of the genital organs are hindered and he may be too lazy and unwilling to work.

Inversely, one which is ill-nourished may also be sterile and the optimum is a lean and active state. The ration should include green foods for the provision of Vitamin E (anti-sterility) and adequate minerals should be available The bull should have ample exercise in the open air.

Rigs (males in which one testicle fails to descend into the scrotum) are not infertile, but as the testicle still within the body is not productive, only half the normal amount of sperm is available for fertilisation. The retained testicle may set up infections in later life and these animals should be castrated and fattened for slaughter. Double rigs, in which both testicles remain in the abdomen, are occasionally found.

Lameness, or inflammation of the penis may so pain a bull that he will refuse to mount. Any apparent swelling of the scrotum should be investigated, as it may be symptomatic of injury to the testicles or epididymis. Both these conditions inhibit sperm production.

Should the accessory sex glands be diseased and cease to produce their secretions, the sperms become incapable of surviving the passage through the urinary tract. Until the condition is cleared up, the bull is, of course, sterile.

Changes of food and surroundings may interfere temporarily with a bull's productive powers and occa-

sionally a young one will not realise his duty when first confronted by a cow in heat.

The age of the bull is not important provided he is managed accordingly. Young bulls should be gradually introduced to work at 15—18 months and well nourished, while older bulls, particularly of the dual-purpose breeds, may require severe limitations in their diet if they show signs of adiposity. For a time, hay and water may be sufficient. A mature bull should be able to deal with 60 cows.

Some farmers feel that an old bull should not be used. There is no reason why this should be, as, provided he is getting stock, no deterioration in the quality of his offspring comes with advancing age.

One very interesting point, which has not had much consideration from geneticists, is that ageing bulls seem not to "shuffle" their chromosomes to the same degree as younger animals, with the result that their progeny receive a larger share of characteristics of one or other of the sire's parents. In this way, a calf got by an old bull may resemble very closely either of its paternal grandparents.

Young bulls should be given light work at first—say single service of about 30 cows spaced throughout the year. Overwork when young results in decreased sperm production in later life. Puberty is attained at an early age, and, although very young bulls are anxious for work, they must be kept apart from cows in heat until they are sufficiently developed.

Finally, willingness to mount the cows and even the production of semen must not be taken as a guarantee of fertility. If all appears to be in order and yet the bull's powers are doubted, a sample of the semen should be microscopically examined.

Failure to Breed—The Female

The sequence involved in heat and conception is complicated and failure of any one of several functions may cause sterility.

In males, sperm production is continuous, but it is believed that the ovaries contain at birth the full quota of

eggs and that no further production takes place. From puberty, the existing eggs are merely ripened and shed.

Recent work has cast some doubt on this theory and it has been suggested that in some species, possibly including the cow, there is a degree of post-natal egg production or, alternatively, that the eggs contained in the ovaries at birth atrophy and are replaced by new development. In any case, the problem does not affect the animal's breeding capacity, as there is no danger of a cow becoming sterile because her last egg has been shed. There are many more than can be shed in a lifetime, as can be seen if an ovary is cut into thin slices. Each slice shows hundreds of immature eggs. Marshall and Hammond (Bulletin 39—Ministry of Agriculture) gave the number in heifer ovaries as 75,000

Feeding and General Conditions

Inadequate feeding, particularly of proteins, reduces the ability of the ovaries to function, and sterility from this cause is often found in badly reared heifers. As it is difficult to get mature cows to calve in autumn, it is usual to arrange heifers' calvings for that period, so that the winter milk rate is kept up. Heifers run outside in early spring (to calve in October they must be served in February) may not shown signs of heat, and to aid in this, a stimulant to ovarian activity may be given. Proprietary drugs which give satisfaction are available.

The difficulty in getting heifers and cows to settle in calf in late winter appears to result from a lack of functional energy caused by general winter conditions and feeding. Symptoms of heat may be very slight at this time.

Mineral deficiency, especially of phosphorous, has been found to result in sterility and has been obviated in the case of hill cattle in Scotland by heavy application of phosphatic manures to the pasture. Insufficient calcium may have similar results until the balance is restored in the ration. These and other mineral deficiency troubles are avoided if a mineral supplement is fed in all cases where there is a reason to speculate. It is interesting to note that, since dried grass was introduced as a winter feed,

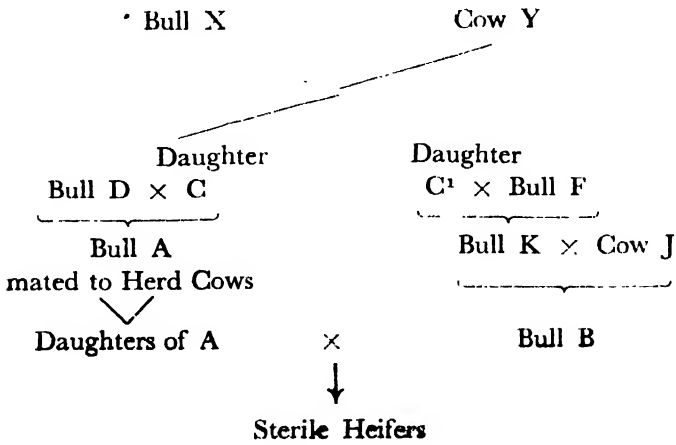
the incidence of temporary sterility has, in some cases, disappeared. The probable reason is that unsuspected mineral and vitamin shortages were overcome. Green food is specially valuable in this respect.

Over-fatness, which permits fatness to gather round the ovaries, depresses activity so that no eggs are shed. This condition may persist for a period after body fat has been reduced, as the ovaries are slow to regain their functioning powers.

Heredity

A further, and more serious cause of sterility, because it cannot be cured, is an inherent disability on the part of both males and females to produce functional sperm and eggs. This condition is hereditary, and animals which are poor "getters" should not be used for breeding. If an animal has a double dose, that is, through each parent, the fault becomes complete.

A case of unsuspected line-breeding which resulted in sterility, recently came to the Author's notice. A farmer bought a bull, unrelated as he thought, to his cows, and the heifers got by him proved to be completely infertile. On further investigation, the following lines of descent were shown: —



The Cows C and C^1 were, of course, sisters, and had inherited poor fertility through either of their parents, Bull X or Cow Y. Therefore, when the daughters of Bull A (granddaughters of Cow C) were mated to Bull B (grandson of C's sister C^1), the heifers produced received a double dose of infertility, and were more or less completely sterile.

To avoid similar danger, an extended pedigree, going back to the great-grandparents, should be examined before a bull is brought into the herd.

Functional Failures

Although maiden heifers may be willing to stand to the bull, it is sometimes found that he cannot penetrate. The cause is a tough hymen, or protecting membrane, which stretches across the entrance of the vagina. The hymen normally has a small opening and when this is absent, the fault may be corrected by gentle cutting. Accumulations of waste products lying behind the hymen must be cleared out with a mild antiseptic.

Should the Corpus Luteum persist following an abortive heat, œstrus cannot recur until it breaks down or is removed by manipulation through the wall of the bowel. This defect may occur in heifers as well as cows, and after the Corpus Luteum is removed, heat returns in a few days.

Occasionally it is found that cows are almost constantly in heat but will not conceive. This condition (nymphomania) is caused by the formation of cysts on the ovaries which prevent the development of eggs. If the cysts are manually removed by the same method as for persistent Corpus Luteum, the trouble ceases, though in some cases it is necessary to repeat the treatment.

The removal of objects from the ovaries must be left to the veterinary surgeon, as inexperienced workers may damage the bowel and the ovaries, with serious results.

Undue postponement of the mating of heifers and cows should be avoided. When an animal is allowed to remain empty for a long period, the succession of heats tends to upset the ovarian cycle. Heifers should be bred from as soon as they are judged to be sufficiently developed and

with cows, no more than three months should elapse between the birth of the calf and the next mating, provided the general health is good.

Occasionally an in-calf cow will return to heat when the pregnancy is taking a normal course. The reason for this is not known. But should this happen in the early stages of pregnancy, and the desire for the bull be repeated at normal intervals, it is probable that the embryo has died and has been aborted or re-absorbed by the system. While not common in healthy cows, this fœtal atrophy is a regular feature in sows, a proportion of embryos dying in every pregnancy.

Local Infections

Bacteriological infections of the genital system are a frequent cause af sterility These may be general, i.e., infecting the whole tract or confined to such parts as the fallopian tubes, uterus or the vagina. These infections often result from unhygienic methods at the previous calving. Animals infected in these ways may come on heat, but as sperms cannot survive in the conditions, conception is impossible.

Metritis is a serious cause of infertility. It results from unclean conditions at calving or retained afterbirth and becomes evident within a week of parturition. The cow is distressed when micturating and a discharge from the vulva, gradually deepening in colour until it becomes brown, is accompanied by a foul odour. The cow stands with her back arched and goes off feed.

Leucorrhœa is a disorder which may be diagnosed by the appearance of small puss-filled pimples on the walls of the vagina and a characteristic whitish discharge (hence the name "whites"). Treatment by cleansing with Condy's Fluid is usually successful. It is, however, unsafe to treat these conditions without veterinary advice.

The formation of a mucous block at the womb entrance may prevent the entry of sperms and in this event, fertilisation may be effected by artificial insemination, when the syringe must be pushed right into the womb. Any disorder causing swelling of the fallopian tubes may also prevent the passage of eggs and sperms.

The secretions of the vagina are normally acid, and sperms can live in them only for periods up to three hours. If the bull ejaculated into the outer end of the vagina, it is possible that no sperms would survive. However, the penis is longer than the vaginal passage and should reach the cervix, so that many sperms probably find their way directly to the womb, where the alkaline secretions are suited to their progress.

Artificial insemination, by allowing sperms to be injected straight into the womb, overcomes vaginal acidity, as the sperms do not make contact with the acid. A.I. is also effective when obstructions or structural abnormalities in the lower part of the genital system prevent the sperms from reaching the egg.

Age of Cows

Age of itself will not cause sterility or impair the development of the calf, though conditions arising as a result of age may do so.

It is popularly considered that the first offspring of a female is smaller and weaker than those subsequently born, and pig breeders and dog fanciers do not usually keep animals from first litters for breeding. However, if a heifer is well grown and nourished, there is no reason why her calf should suffer, but if she is mated too early, at the time when she requires most of her energies for growth, the calf would, most probably, be handicapped.

Many cows have produced calves annually for 16—18 years, but as age advances, the tendency is for functional weaknesses in the dam to influence adversely the progress of the fœtus. The farmer must decide for himself the stage at which each cow must be withdrawn from the herd on this account.

Abortion and Still Birth

After the embryo is on its way, loss can still occur, as it may be aborted or, when the normal time for birth comes round, it may be born dead. Abortion may be caused by the failure of the Corpus Luteum to retain its place throughout pregnancy, when the œstrogenic hormones take over and promote labour prematurely.

Abortions may also be brought about by accidents, excitement, and malnutrition. Still birth results from accidents, gross underfeeding and, possibly, from blood variations between the sire and dam.

If the calf is still-born, the cow's milk yield is not restricted and the loss of the calf, serious as it is, is the only harm suffered. In abortion, however, heifer yields are lowered seriously and if the calf is slipped before the fifth month, it is unlikely that any milk will be produced. Cows already in milk may show some increase in production, as the aborted calf ceases to be a drain on the food taken in by the cow.

Sterility and abortion arising from contagous abortion will be dealt with under Health and Disease—Chapter XIV.

Twins

Although a cow normally sheds only one egg in a heat period, the shedding of two and even three sometimes occurs. Multiple births are not wanted in dairy herds as the calves are usually slower starters and the extra strain thrown on the dam tends to reduce her yield for the lactation. Twins of the same sex are normal animals, but where a calf of each sex is born, the female is, in most cases, barren. Such heifers are known as "freemartins" and are sterile because the male hormones of the blood mingle in both animals and prevent the proper development of the female genital organs. The females born as twins to bulls have the appearance of normal animals but will not come into season. Twinning is a hereditary character in females, and while the bull is not responsible for twins resulting from his own matings, he may pass the trait on to his daughters.

By now, the reader may feel that the chances of ensuring fertile matings and the birth of a live calf are small indeed, but in practice, if the progeny of stock known to be healthy and fertile is used for breeding, and feeding, management and hygiene are correct, most of the contingencies described will be avoided. The most common will be some delay in getting cows to breed at the required intervals, and to overcome this, studied feeding and close observation are the only aids.

In concluding this section, it may be said that the author has seen animals of promising appearance culled from herds because they either refused the bull or did not come into calf. Had these animals been submitted to veterinary examination, it is quite possible that a simple remedy would have been found and the loss of the stock avoided.

Factors of Management which Affect Milk Yields

The dairy cow has been described as the hardest worked animal on the farm. This is no mere platitude, as, not only does she normally calve each year, but, three months after calving she is again pregnant, and while she carries each calf (after her first) she is expected to continue milking on a much higher plane than Nature intended. And for more than half the year she must live and produce on unnatural foods. Yet she must not be pampered.

Interval of Calving

Every month's delay in mating heifers after they reach a suitable stage of growth means greater difficulty in settling them in calf and also that the subsequent milk yield may be reduced. On the other hand, while delay in re-mating mature cows also reduces the chances of a fertile service, the yield in this case is increased.

If, instead of serving the cow within the usual three months of the birth of the previous calf, she were left barren throughout the lactation or even for a substantial part of it, her yield would be up by about 20%. However, in commercial farming, the practice would ultimately lead to severe loss, as the delay in mating means a correspondingly long dry, and, therefore, unproductive period. A dry period of about two months has been shown to be the most suitable, as any shorter time is insufficient for recuperation and the succeeding yield is adversely affected. Not only does the frame require building up, but the mammary system is unable to recover the wastages of the lactation except when dry and completely rested. The additional yield gained by leaving cows dry beyond sixty days is too slight to compensate for prolonged idleness. Cows in poor condition may, of course, require a longer rest

and this, like so much in farming, is a matter for individual consideration.

Season

Cows (unless specially stated hereafter, heifers are also implied) calving in autumn usually produce higher yields than those calving at other times. Not only does the summer grazing give them an excellent preparation, but the flush of spring grass, coming at the time when the lactation is on the downward curve, acts as a stimulant and the drop is partially arrested.

Stage of Lactation

Most cows reach the peak of their lactation sometime in the second month. Some have a high peak followed by a relatively sharp fall, while others are more level throughout. In each case, day to day differences are slight, and should a noticeable drop occur, the reason should be investigated. When arranging calvings at yearly intervals and allowing dry periods of two months, the desired length of lactation is, of course, ten months. In their report to the M.M.B (1946—1947) the Bureau of Records show that only 41% of cows milk for this period or longer, while 16.1% were below seven months, the remainder being between seven and ten months.

Effect of Age

Yield increases with the age of the cow, reaching maximum at the seventh lactation. In the report already mentioned, the Bureau of Records give the following figures for the six main breeds:—

Lactation	1st	2nd	3rd	4th	5th	6th	7th	8th
Average Yield lbs.	5,902	6,362	7,033	7,342	7,460	7,418	7,583	7,351
Index: 1st—100	100	107.8	119 2	124.4	126.4	125.4	128.5	124.6

Lactation	9th	10th	11th	12th & over
Average Yield lbs.	7,151	6,940	6,656	6,731
Index: 1st 100	121.2	117.6	112.8	114.0

When reviewing these figures, the loss of milk sustained by the low national average of 3.1 lactations is realised.

Occasionally a cow may show a great jump in production in her third or fourth lactations. Besides the possibility of some physiological disorder having righted itself, the most probable cause is that the cow has had a poor start as a heifer and has been able to outgrow the handicap.

Effect of Secretion

As pressure rises within the udder, further secretion is inhibited so that, if cows are incompletely milked, the yield falls In high yielding cows or those with very small udders, the vessel fills rapidly and the pressure on the alveoli may be sufficient to stop production some time before the cow is due to be milked. The yield is progressively reduced in this way. Such cows should be milked three times daily, and exceptionally high yielders such as those engaged on record attempts, are frequently milked four times. With average herds it is common to find an increase in production of about 20% when cows are changed from twice to three times milking per day, but the labour costs incurred may outweigh the gain and it is usually only on farms where the herd gives a high performance and where a reserve of labour is available for the routine that three milkings are practised. There is reason to believe that the more frequent milking keeps the cows contented and assists in maintaining health.

General Management

Irregularity of feeding, rapid changes of food or a break in habit all cause the yield to fall, as does impending sickness. A slight, temporary fall normally occurs a few days after heat.

Comparison of Costs

No matter the level of production, cows of equal size require the same amount of food for maintenance. It

follows that the higher the yield, the greater the gallonage over which the costs are spread, so that the costs per gallon are progressively reduced. This may be illustrated by the simple table shown below, which assumes for ease of reading, that maintenance cost per cow is 2/- daily, while the concentrate ration for each gallon of milk costs 1/-.

Yield per day—Gallons	0	1	2	3	4	5	6	7
Maintenance per day	2/-	2/-	2/-	2/-	2/-	2/-	2/-	2/-
Concentrates (1/-) per gallon	—	1/-	2/-	3/-	4/-	5/-	6/-	7/-
Total Cost of Food	2/-	3/-	4/-	5/-	6/-	7/-	8/-	9/-
Cost per Gallon of Milk	—	3/-	2/-	1/8	1/6	1/5	1/4	1/3

There is, however, a limit to which this ruling applies, as beyond a certain yield, cows require special feeding and management which may eclipse the value of the extra milk produced.* It is known, moreover, that to force cows for exceptionally high yields lowers the constitution and leaves the way open to diseases, and the optimum yields for the various breeds, both economically and with a view to preserving health, are probably very near to the figures given below:—

British Freisian —	1,250 gallons
Dairy Shorthorn - -	1,000 gallons
Red Poll	— 800—1,000 gallons
Ayrshire	— 800—1,000 gallons
Guernsey	— 800— 900 gallons
Jersey	— 800 gallons

This is, very roughly, about 1 gallon per lb. liveweight

In order to ensure a level flow of milk throughout the year, the following sequence of calving dates is suitable:—

1/3rd of the cows to calve January to March
1/3rd of the cows to calve July to September
1/3rd of the cows to calve October to December

* *Note.* While this statement is true in a general sense, it is interesting to note that many famous high yielding cows have lived to produce seven and more calves.

No calvings are timed for April to June, as the January to March calvers are then at their peak, while the yields of the others receive an impetus from the spring grass.

It is not wise to push heifers for very high yields, as the constitution is thereby lowered. Where they must conform to certain standards, as for bull breeding or Breed Society qualifying yields, the required standard should be aimed at and no more. It is significant that the heifer yields of Red Polls, the longest lived breed, provide the lowest ratio when compared with mature yields

Factors Affecting the Quality of Milk

As with yields, the breed to which the cow belongs is only a general indication of the quality of milk she will produce, and each cow must be judged as an individual. The separate abilities to produce high yields and good quality often prove difficult to combine, and apart from breeding from strains known for good quality, little can be done for improvement. However, some attention to detail will ensure that the quality of milk sent out from the farm is the highest that the cows are genetically capable of producing.

The reactions of fat to various influences are inconsistent, but usually when the yield is caused to fall, fat rises, and vice versa. In many cases the change of proportions is temporary and results from the time lag between the response of the fat secreting agents and those for total yield. The latter is the more rapid.

When changes occur in the composition of milk, protein and ash (the latter very slightly) move with fat, while lactose moves in the opposite direction. Any increase in solids naturally reduces the water content.

Condition of the Cow

Cows in good condition at calving produce more fat, especially in the earlier stages of lactation, than those brought along on a poor nutrition plane. Injections of hormones have been successful in improving quality, but this method is still in the experimental stage and does not appear to be desirable for commercial use. The yield of cows which are underfed following parturition falls

more sharply than the butter fat and, consequently, the milk produced is richer than in similar animals which are well fed.

Age of Cow

Butter fat is usually slightly higher with the first calf, but little variation occurs in the second and following lactations, provided the cow is healthy. Udder troubles often cause a reduction in older cows.

Stage of Lactation

On the day of calving, fat may be as low as 1.5%, but rises sharply to the highest point within a week. As the yield climbs to the maximum (at 4—8 weeks) fat declines, but rises slightly as the lactation continues on a lower level.

Day to Day Variations

Some cows scarcely change from day to day, but others show differences as great as 1% on successive days, without apparent reason.

Efficiency of Milking

The first drawn milk is poorest in butter fat, the quality rising as milking proceeds. The content may be about 2% for the first few strones, while the final drops may contain 8—9%. *To secure the highest level, the udder must obviously be milked right out, or "stripped".*

Season

Temperature has a marked bearing on quality which appears to coincide with the needs of calves. As the temperature rises, the fat content falls, and it is unfortunate that, when many cows are at peak yields in summer, fat production is reduced both by the high point of the lactation and the warmer weather. This is a period at which a farmer stocking cows which normally produce the bare requirements of the Legal Standards, could find himself

in danger. Also, if the cow shed is heated substantially above 50° F. in winter, the yield of fat may fall.

It is commonly thought that turning cows out to grass in spring has a lowering effect on solids production, but it is the warmer temperature rather than the change to grass which causes the drop. A contributary cause may be the lower vitality of the cows following the winter period, as the change is not so marked in well fed animals.

In general, besides breeding for quality milk, the only way to keep up the solids content in the warmer months is to feed the stock well in winter and to arrange calvings throughout the year so that the cows are all at different stages of their lactations. This latter condition is not always easy to fulfill.

Times of Milking

Another means by which the farmer can help to secure even quality of milk is by care and regularity in milking. Milking times should be as evenly spaced as possible, though workers' hours often make this difficult.

For cows milked twice daily, the ideal is to have the intervals of twelve hours each. Even then, the morning milking will give a slightly higher yield but lower quality. For each hour's interval over twelve, the yield is increased but the quality falls by .1% or .2%, while for each hour under twelve, the yield is reduced but the butter fat rises by .1% or .2%. The figures given below are fairly typical of what happens:—

Milking times	Yield lbs.	Butter Fat %	
5 a.m.	15.5	3.2	after 12 hours
5 p.m.	15.0	3.4	after 12 hours
Total for day	30.5	3.3	average
7 a.m.	16.5	2.9	after 14 hours
5 p.m.	13.5	3.7	after 10 hours
Total for day	30.0	3.3	average

The example given has been deliberately based on a herd very near to the Legal Standards (3% butter fat), and shows how a farmer, retailing morning milk after an interval of 14 hours, might well render himself liable. When milk is collected once daily, there would be no danger as the milk is bulked and the general sample would be 3.3% butter fat.

The highest yielding cows, which normally give the poorest milk, are usually milked first in the morning and last in the afternoon, so that the interval between milkings is as even as possible. If the milk from these cows were bottled or put in cans, the sample might, especially in the mornings, be below the Standards. This may be avoided by mixing the milk of several or all of the cows as it goes into the containers. For this purpose, the cooler over which the milk passes, should have several outlets so that each cow's milk is distributed over a number of cans.

Feeding

There is no clear evidence on the effect of feeding on fat production. Unrestricted feeding on protein rich grass has been blamed for a drop, while foods such as succulents which stimulate the flow of milk may reduce the fat, but only temporarily. Some oil cakes are said to improve fat yields. Palm kernel cake and coconut cake effect a small but lasting improvement. Cod liver oil depresses fat production.

Foods may also influence the texture of fat. Soft fats are produced by succulent foods, oats and pasture, while beans and coconut cake produce hard fat. Soya bean meal and linseed give an oily fat. These are general claims, but Scottish experience does not confirm them.

Solids-not-Fat

A fairly extensive falling off in solids-not-fat has been noticed lately. These solids tend to fall in winter and also when the lactation is at its highest point, rising again as the yield diminishes. Irregular breeders, that is, cows with a long interval between calvings, give milk poor in this respect.

No definite evidence either of cause or cure is available, though work at Jeallot's Hill has shown that the feeding of dried grass improved the rate, but had no effect on butter fat.

In the meantime, farmers should be careful to breed only from stock giving solids comfortably in excess of legal requirements.

General Management of Dairy Herds

Apart from any supplementary feeding which they may require, cows look after themselves fairly well in summer. There are, however, a few points which may lighten the the work on the farm and improve the efficiency of the herd.

It is usually more convenient to turn cows into a field close to the steading after the evening's milking. A long search and drive home is not pleasant in the early morning when time is usually short. It has been stated that grazing cows eat almost as much through the night as by day and, because it is not usually convenient to change their field in the evening, they should be kept out of the richest fields at this time. It is interesting to note that cows are believed to spend eight of the twenty-four hours eating, eight hours chewing the cud, and the remaining eight at rest. These spells are not of course, continuous. Cows may, for instance, ruminate for spells of five minutes to an hour.

Milk animals and, even more important, pregnant animals, should never be hurried. For this reason, dogs should not be employed to bring them in for milking. It is equally important to avoid exciting them as they enter the byre or milk parlour, as many accidents are caused through harassed cows slipping on cement floors. While floors should have a surface which is easily cleaned, some roughness should exist to provide foot grip.

The size of byre stalls is important. If they are too short, cows stand with their rear feet in the grip or dung trench, and if too long, they deposit dung on the standing and lie in it. Again, stalls which are too narrow often cause injuries through a cow standing on some part of her neighbour when rising. Such accidents are a frequent cause of teat injuries.

Stall areas for double standings should be:—
Average sized cows—5 ft. 3 ins. long, 6 ft. 6 ins. wide.
Large cows —5 ft. 9 ins. long, 7 ft. wide.

It is often noticed that farm steadings and the roads to the fields are soiled by dung. Besides being unsightly, much good manure is lost to the fields and the dungstead. It is quite simple to avoid this by training the cows to evacuate as they are released from their stalls. On a farm on which the author spent some years, it was the custom for the stockman to clap his hands when he was ready to let the cows out, and as each one obeyed the signal, she was untied and free to make for the grazings. The habit was easily learned by the animals and it was rare to see droppings about the farm.

A further byre point of great importance, especially when breeds with upturned horns are considered, is to keep the head well clear of any possible movement of the cow's head when tying, releasing or feeding. Severe facial and eye injuries have been caused by failure to observe this precaution.

In summer, flies become a menace and, besides the danger of carried infection, irritation in severe cases is sufficient to cause a drop in yields. Byres should be sprayed with insecticides whenever this appears to be necessary and the dungstead should be kept as far from the cow sheds as possible.

Cleaning of byres, both in summer and winter, should be done twice daily, after milking, and should be done at regular times each day. The floor should be liberally hosed with water and thoroughly swept. Frequent lime washing of the walls acts as a disinfectant and increases the incentive to cleanliness. The law stipulates that lime washing be done every half year.

In winter, when cows are housed most of the day for a long period, it is sometimes difficult to keep the higher yielders on their feed. The stockman should watch carefully for any signs of failing appetite and must decide whether it is a case of sickness or merely that a change of diet is required. Many cows are quite individualistic in their taste, and it may be necessary at times to depart from the accepted standards.

All cows should be allowed out daily if possible, but must not be forced to stand bedraggled and miserable in

wet and windy weather. On particularly severe days, they are best kept in.

Grooming has been likened to the hoeing of plants. After hoeing, plants stand up bright and fresh, and the grooming of housed stock imparts a similar exhilaration. Where it is impossible to do the whole herd daily, half or one-third may be groomed, which means that each cow is attended to every two or three days.

Apart from the wise use of the ventilating system, care must be taken to see that doors are not left open in severe weather. On farms where food, more frequently fodder, must be brought from a separate building, it is very easy to fall into the habit of leaving the doors open until the entire stock is fed. Such treatment may easily result in chills and udder troubles.

If shelter belts are not available, some form of protection, particularly from the sun, is advisable. A rough shed, open at the front, will suffice. This has the additional advantage of giving respite from flies, which will not follow stock into shade.

It is essential that all stock be inspected daily. Milk cows are seen regularly, and the farmer should make a point of seeing all dry cows and heifers. The last job at night should be to look round the housed stock.

Many of the points and difficulties of winter management are avoided when the cows are yarded.

Further reading. *Farm Animals*—Dr. John Hammond, Edward Arnold & Co.

Good and Healthy Animals—D. Paterson, English Universities Press, Ltd.

Black's Veterinary Dictionary—A & C. Black.

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CHAPTER XIII

MILKING

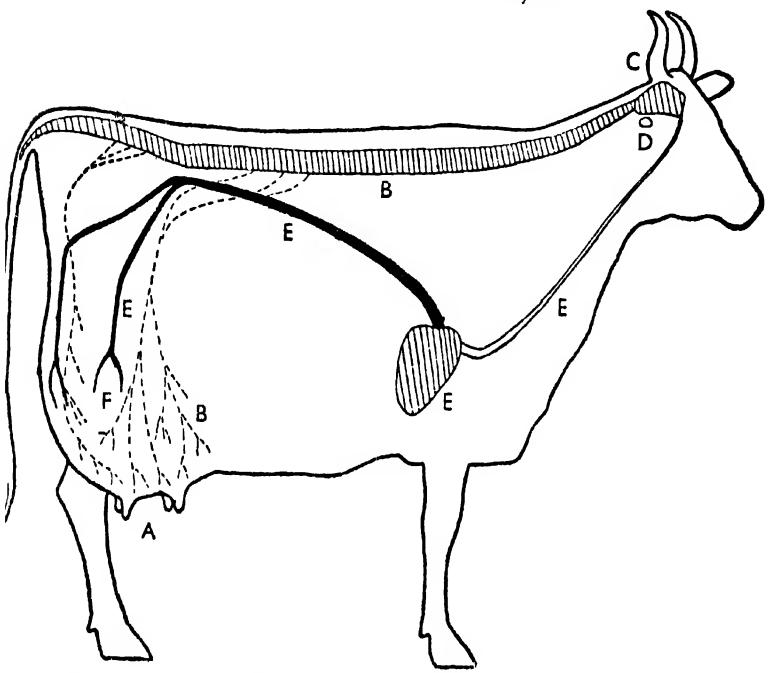
THE efficiency with which milking is carried out has great bearing on the amount of milk which may be obtained at a single milking and throughout the lactation, *as well as on the span of useful life which may be expected from the cow.*

Just as many other special body functions are possible only under the influence of hormones, so is the cow's willingness to "let down" her milk controlled. The hormone concerned is oxytocin and its release by the pituitary gland is dependent upon outside influences which set up a nervous reflex within the cow. The effect of oxytocin is to contract the muscles round each of the alveoli and so dispel the drops of milk contained. Dr. Peterson (U.S A.) has found that from the time of the reflex "registering", only 40 seconds elapse before the hormone becomes effective. The influence lasts for seven minutes, so that if milking is to be in harmony with the reaction of the cow, it must be commenced immediately the let down occurs and completed within seven minutes. If this is not accomplished, milking will be incomplete and if continued the effect becomes cumulative and secretion is reduced until eventually the cow dries off prematurely.

The release of oxytocin follows influences to which the cow has become accustomed at milking time—the rattle of pails may be sufficient with some, while massaging the udder or the actual commencement of milking causes the reaction in the majority of cases. The let-down may be felt by the sudden filling of the lower part of the udder.

If it is observed that a cow releases her milk by the mere sound of the equipment, she must be milked first, while for the others, the stimulus of massage or washing the udder must be delayed until each is about to be milked.

Nothing must be allowed to interfere with circumstances favourable to the "let-down". Harsh or sudden noises, rough treatment or unusual happenings may easily do so by frightening or angering the cows. When a cow is alarmed, another hormone, adrenalin, which raises the blood pressure and prepares the animal for defence, is released, and inhibits the secretion of oxytocin.



Massage of teats (A) sends message along nervous system (B) to brain (C). Pituitary gland (D) then releases hormone oxytocin into blood stream (E). Hormone reaches upper udder and causes release or let down of milk.

In the period between milkings, some of the milk passes down to the lower part of the udder (i.e. to the larger ducts, the milk cisterns and the teat cavities) but the greater proportion remains in the alveoli. The first drawn milk is poor in butter fat while the last few drops may contain as much as 9% fat, which suggests that, as

fat is the lightest and most viscous of the constituents, it does not readily descend to the ducts but must be expelled by the contraction of the alveoli, which can only be induced by thorough milking.

Stripping, which means that efforts are made to remove every drop from the udder is therefore commonly practised, though some farmers disagree with the principle. Those opposed to stripping contend that if milking is stopped as soon as the flow ceases, the cow will rapidly learn to give up the entire contents of the vessel, without further persuasion.

Clean Milk Production

Bacteria in Milk

Besides the legal standards concerning butter fat and solids-not-fat, milk is graded for quality according to its cleanliness as measured by the bacteriological content. It is therefore necessary that those working with milk have some knowledge of the life of bacteria, the way they work, and the means of combating them.

Bacteria are amongst the smallest of living organisms. They belong to the plant world and are not tiny insects, as many people believe them to be. Because they cannot be seen by the eye unaided, their existence is often ignored or forgotten, yet without their presence, milk would not turn sour nor would disease be contagious. There are many types of bacteria ; some are harmful to other forms of life (disease germs) while others, such as those contained in the flora of the digestive tract and soil microbes, are helpful if confined to their proper place. Vast numbers of types have no apparent effect and are meantime of botanical interest only. Bacteria exist literally everywhere—on walls, clothing, milk utensils and in the air, and only the most complete cleanliness will keep them in check.

The types which mainly concern the liquid milk producer may be classified by their shape and by their effect on milk and on the ultimate consumer.

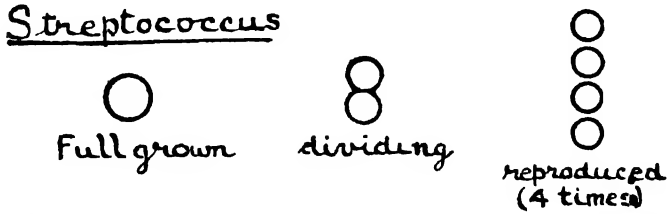
Cocci, which are spherical and on reproduction form strings like beads (Streptococci) or cluster groups (Staphylococci) appear to be naturally present in milk. The one invariably found in Britain is Streptococcus Lactis, which acts on lactose and causes souring. While useful in processing (milk set for butter making is first soured by a "starter" which is merely a Streptococcus Lactis culture) it is undesirable in milk to be sold sweet. Other cocci cause off flavours and odours in addition to souring.

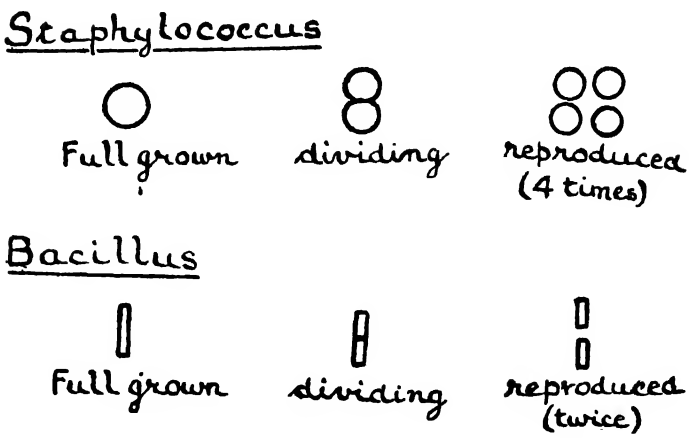
The other important type of bacteria is the rod-like bacillus which, except for those of the coliform group, are not frequently found in milk. Coliform bacteria, of which B. Coli is the chief, occur naturally in the intestines and pervade the air when released by excretion and again when the fæces dry. The flanks, udders and teats of cows are, through their contacts with dung, the main source of contamination, but dirty milk-shed equipment, bedding, and even fodder and pasture may carry vast numbers. Their presence in milk reveals dirty conditions on the farm.

In combination with the lactic acid group, B. Coli promotes souring, off flavours and odours. In small numbers it is harmless to health but may cause intestinal disorders in children.

The dangerous type of bacilli are the disease organisms such as the tubercle bacillus and B. Typhoid. These should not be found in milk, but may be introduced by unhealthy cows or infected workers.

Bacteria multiply when the environment is suitable and unfortunately, milk provides all the food, moisture and oxygen that they require. In favourable conditions they grow and reproduce in twenty minutes and do so by merely enlarging and dividing into two parts, thus:—





The rate of progress is extremely high and in 24 hours one germ could develop millions. The temperature at which bacteria are maintained influences the rate of activity. Disease types which invade the body are most virile at blood heat (98° F.) while those whose natural home is milk, thrive best at about 70° F., the temperature to which milk falls in normal summer storage conditions. The optimum temperature for coliform bacteria is, of course, blood heat, but they are little impaired by normal milk temperatures. Outside these temperatures the germs either die or become inactive.

It is obviously necessary to kill disease germs which may be present, and it has been found that the most difficult of these to destroy is B. Tuberculosis. Therefore, if milk is heated to the thermal death point of this bacillus, no further danger to the health of the consumer exists.

Pasteurisation is, of course, designed to this end, but the temperature necessary (162° F. for 15 seconds) is not sufficient to kill all the other organisms which, though not harmful to man in reasonable numbers, impair the keeping qualities of milk. At that temperature, beyond which it is not desirable to heat milk, some of the Streptococcus Lactis survive, and if the milk is allowed to return to the normal temperature of 70° F., these cocci resume activity. To obviate this, milk must be kept at a temperature as

far below 70° F. as is practicable, and the nearer it is to 50° F., the longer it will keep sweet.

Freezing has been suggested as an alternative to pasteurisation, but when milk was frozen to 200° F. below zero, bacteria resumed activity when the temperature returned to normal. How low the temperature must be to obtain results similar to pasteurisation is not known.

Other organisms thrive in heat. These are known as thermophilic bacteria, and their activity is encouraged by pasteurisation. Their presence results from badly kept utensils. Pasteurisation is not, therefore, a "pardon" for dirty production.

Moulds, yeasts and bacteria which cause butyric acid are unimportant in the liquid trade, but if present in the milk from which butter and cheese is made, cause serious defects in the product. Butyric acid bacteria make fat turn rancid and are encouraged by cold weather, so that even winter provides no let-up in the need for care. The butyric forming group is more resistant to heat than Streptococcus Lactis, and accordingly, milk reserved for processing is heated to a higher temperature. All of those types are associated with dirty conditions.

Udder troubles such as mastitis and "ropy" (see chapter on Health and Disease) are a further cause of contaminated milk.

No milk is naturally sterile. If a healthy cow with clean udder and teats were milked into a sterilised bottle under the most hygienic conditions possible, the sample would contain about 100 bacteria per millilitre. If the milk were kept covered at 50° F., it would retain its quality for some days, but under normal atmospheric temperatures, the bacteriological count would, in a few hours' time, run into many thousands, and the milk would turn sour.

To those not acquainted with bacteriological populations, it may come as a surprise to learn that, when the Bacteriological Standards were stated for each grade of milk, the permitted numbers ranged between 30,000 bacteria per millilitre for Certified and T.T. Pasteurised to 200,000 per millilitre for Standard (raw) milk. No coliform bacteria was permitted in 1/10th millilitre and 1/100th millilitre respectively, which means that the milk had to be free of this type.

Though the permitted numbers of bacteria may, at first

sight, appear large, great care is needed in producing milk to these standards. This will be seen when it is realised that milk may be tested many hours after it is produced, during part of which time it may have lain exposed to the sun on a retailer's lorry. One hour at 70° F. may easily raise the count from 50,000 to 300,000 bacteria per millilitre, so that milk has to be very clean when it leaves the farm.

The position only becomes serious when the numbers approach half-a-million per millilitre.

National Milk Testing and Advisory Scheme

To assist the trade in maintaining a high quality, this scheme was launched in 1942.

Under its provisions, the receiver on the creamery platform examines each can, and if he is doubtful of its keeping quality, a sample of the milk is subjected to a more thorough but rapid test. According to the results of this test, the milk is classified thus:—

Class I.—Good.

Class II.—Suitable only for processing.

Class III.—Rejected—returned to farmer.

If there is no outlet for processed milk at the creamery, Class II milk is also returned.

When milk is classed II or III, the occurrence is reported to the local Agricultural Executive Committee, the farmer is visited and, after the premises and equipment have been examined to find where the fault lies, he is offered advice on how to improve his product. Only after several failures are serious steps taken, and in this event, the farmer would probably lose his licence.

While the tests now employed are not an actual count of bacteria, the reactions of the agent used (Resasurin) are influenced mainly by the numbers present.

General Procedure at Milking

While bacteria pervade even the air, they congregate and thrive chiefly in dirt and darkness. Hence, all milking operations should be carried out in clean, dust free and well lit buildings.

The means of keeping dust down have been mentioned,

but may be summarised by saying that the foddering and grooming of cows and the cleaning of the byre should be done some hours before milking or immediately after it. With regard to grooming, the hindmost parts of the cow and the flanks must in particular be kept clean, so that no particles of dung or dirt may fall on to the milking utensils or into the milk. All long hairs appearing on the udder should be cut away, and it is advisable in winter to clip the hair short on the tail and flanks.

Before each cow is milked, the udder and teats should be washed with warm water to which disinfectant has been added, and for hand milking, the right flank and thighs should also be washed. The parts should then be wiped over with a fresh cloth, also sterile, dipped in a separate pail and wrung out. It is of course, essential that the milkers' hands are washed and disinfected, not only at the commencement of milking but, for safety, before each cow is begun. Machine cups should be dipped in a weak solution of suitable disinfectant and then in cold water between each cow.

The first few strones from each teat should be drawn into a strip cup and examined for abnormalities. This is one of the best and earliest means of detecting mastitis, as its presence is usually betrayed by clots appearing against the black base of the cup. Any cow showing faulty fore-milk should be kept back and milked after the rest of the herd is finished. She should then be isolated until seen by the vet.

The use of the strip cup is also important in securing clean milk. The teat canal remains full from the previous milking and the milk contained in it becomes highly impregnated by bacteria, particularly of the coliform group. If this is allowed to mix with the bulk of the milk, an unduly high count will result.

To discharge the fore-milk on to the floor is a reprehensible habit of some milkers, as the procedure sacrifices diagnostic possibilities and spreads bacteria throughout the milking shed.

Hand v. Machine Milking

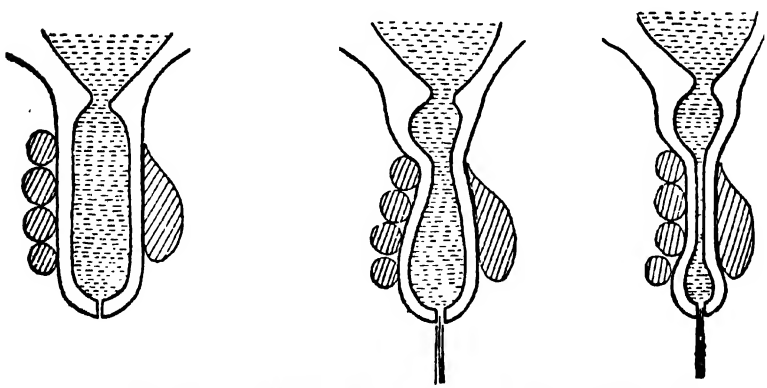
The general merits of hand and machine milking are about equal, the latter scoring principally in the reduction

of labour. On larger farms employing machines, one man, by attending to 3 units, can do the work of two hand milkers, but as a certain minimum of labour is required, this ratio tends to diminish when smaller herds are considered. Often the main asset of the machine is its reliability, as it is not so inclined to take unauthorised "holidays" as men sometimes are; also a smaller team of workers than is normally employed can usually "make do" at busy times, thus releasing labour for harvest and similar urgent tasks.

Some cows definitely yield more milk to hand workers than to the machine and this tendency has even been found to persist in a strain accustomed through several generations to machines. Inversely, some animals have a preference for machine milking and try to lick the bucket as though it were a calf. Generally, it may be concluded that hand milking gives slightly better yields but that the advantage is outweighed by other considerations.

Hand Milking

The principle involved in hand milking is first to get milk into the teat and then to expel it. The latter is done by squeezing the teat between the thumb and forefinger so that the milk in the udder is cut off from the teat. The remaining fingers are then pressed round the



Diagrammatic section of teat and hand to illustrate action of hand milking.

teat to expel the milk. Releasing the fingers allows the teat to fill again. There should be no pulling and tugging and, in a good milker, the only movement apparent is the working of the muscles along the forearm and hands, and the opening and closing of the fingers.

After the milk ceases to flow, stripping begins. The udder should be gently massaged and each teat milked again one or more times until no more can be drawn.

Milking with dry hands is usually advised, though slightly moistened hands do no harm and reduce friction on the teats. However, if the hands are made wet even with clean water the chances of obtaining clean milk are reduced, and when, as still occurs, a milker wets his hands by drawing the fore-milk on to them, a clean product becomes impossible.

If possible, each milker should have his own group of cows, as the animals respond better to one they know. A very good scheme worked on an American farm, where hand milking is practised, is to allocate to the care of one man a number of cows (fifteen in this case) *and* their progeny In this way, every incentive to take a real interest in his "families" is given to each worker.

Machine Milking

There are two main types of machine—the simple bucket type and those which carry the milk through pipes to the dairy. The working of each type is essentially the same, but the latter gives the better chance of clean production, as the risk of contamination from the air is reduced. A valuable refinement on some models is a recording device which automatically weighs the yield of each cow. A glass inset is included in all machines so that the flow can be observed.

When milking nears completion, the rate of flow is reduced by the tendency of the teats to fold up in the cups and so close the canals. If a light pressure is put on the base of the cup cluster (the claw) so that the cups are eased down slightly, the teats straighten and the flow is restored. This, accompanied by gentle massage of the udders, is the method of stripping used for machine milking.

The machine must be run in strict accordance with the makers' instructions and, above all, the pulsator speed should not be tampered with. The cups must be removed immediately the milk ceases to flow, or mastitis will follow.

The Cooler

As soon as each cow is milked, the milk is strained through cotton gauze and cooled. The cooler is an apparatus in which cold water runs upwards through several vanes, while milk runs from the top down on the outside. The milk is collected in spouts and poured into cans.

Much of the keeping quality of milk depends upon efficient cooling. On many farms it is not easy to maintain a constant supply of cold water and this is recognised by the regulations governing cooling. Except for special grades, the Law merely asks that milk be cooled to within 5° F. of the temperature of the water used.

Cooling is more effective when milk runs slowly over the vanes, and this may be assisted by keeping only a "light" head of milk in the vat at the top of the cooler. If the vat is filled the milk is forced down too rapidly. Milk run quickly over the vanes may be several degrees warmer than slow running milk when it reaches the can.

After the milk has been cooled, every effort should be made to keep the temperature low until the cans leave the farm. If these have to be placed at the roadside to await collection by the creamery lorry, a shady site should be chosen.

Brine coolers are more efficient than water and it may be that regulations will eventually be introduced which demand more efficient equipment on every farm.

Cleanliness of Buildings and Equipment

Buildings. The requirement of local authorities in respect of buildings for milk production vary throughout the country, so that it is impossible to discuss them here in detail. One common feature of these regulations is that the cow sheds and dairy must be constructed in a manner

suited to the maintenance of hygienic conditions, as authorities recognise that if the routine is difficult, a high standard of cleanliness is unlikely to be kept. In general, floors must be impervious, the walls smooth and ventilation and lighting adequate. Drainage must also be good and a supply of water available.

Milking parlours are a fairly recent development, and as they are usually contained in a building separate from the others and are, of course, unoccupied except at milking times, they are easily kept clean. These parlours usually contain a store for concentrates, stalls for washing udders, a range of milking stalls each with a trough for feeding concentrates, a boiler house and plant for washing and sterilising equipment.

Cows enter in groups according to the number of stalls available. While these parlours are equally suited to hand milking, it is usual to find elaborate machines installed.

In some milking parlours, the cows are drawn beside a pit in which the milker stands. By this arrangement, the udder is at convenient level for inspection and the milker has the best possible chance of observing any faults and ensuring that the udder and teats are properly cleaned

A further method of improving facilities for inspection is to arrange diffused lighting in the floor so that the vessel is completely illuminated.

Utensils. Only the best quality utensils, preferably seamless, should be used.

The work of cleaning is easier and the check on bacteria more efficient if steam sterilisation is available on the farm. Immediately after use, all utensils should be rinsed in cold water, so that milk does not adhere to the sides, and then washed in hot water to which a suitable detergent agent is added. By this means, all traces of fat are removed. They should then be rinsed again, drained and put in the steam chest, where they should be kept for 10 minutes after the temperature reaches 210° F. If steam is not available, the equipment should instead be put in boiling water. The utensils should not be wiped dry after sterilising, but should be left in a clean place (the steriliser with the door open is ideal) until dry. If the initial rinsing and washing are not thoroughly done, steaming will merely "bake" milk constituents on to the utensils.

When hand milking is practised, the milking stool is a most important item, as it is the last thing touched before each cow is milked. Yet the need for its sterilisation is often overlooked.

The Milking Machine. If the milking machine is properly cleaned and sterilised, it should be at least as clean as hand milking carried out under similarly good conditions. In practice, more trouble has been experienced when machines are used, and if they are not properly maintained, the numbers of bacteria reaching the milk may be enormous. A peculiarity of dirty machines is that the milk of the first cow to be milked is most heavily infected, as the milk spurting through carries away most of the bacteria with it. It may also be mentioned that, in tests carried out on unsatisfactory farms, the bucket of the machine is seldom the cause of trouble. In one case reported, almost 300,000,000 bacteria were taken from the cups and tubes.

The makers' instructions for cleaning should be closely adhered to and if this is done no trouble need be feared.

Personal Conduct. This factor is at least as important as those mentioned earlier. The workers should be acquainted with the dangers of dirt and some knowledge of the foregoing account of bacteriological influences on milk put before them.

Hands should be thoroughly cleansed as the initial operation and white coats, regularly cleaned, should be worn. Women milkers should also wear caps to enclose the hair.

As will be seen in the Appendix, people suffering from ill-health must not work with milk. In addition, workers should avoid breathing into milk, as epidemics have been started by workers who did not themselves know that they carried infection. Finally, spitting and urination in byres, all too common practices, should be prohibited and action taken against any man who breaks this vital rule.

(The line drawings in this chapter are reproduced by kind permission of H. M. Stationery Office.)

CHAPTER XIV

HEALTH AND DISEASE

THE means of keeping stock healthy have been stressed in earlier chapters, and may be summarised as follows:—

1. Breed only from healthy families.
2. Maintain a high level of cleanliness in cattle houses, feeding utensils and during sickness and at parturition. Pastures should be kept fresh.
3. Good ventilation of houses and the avoidance of draughts and dampness. Good light and drainage in all buildings.
4. Correct feeding, paying regard to the effect on bowels, vitamin and mineral content, as well as the PE/SE balance. Avoid overfeeding and offer only fresh foods.
5. Regular exercise and fresh air.
6. Prevent stock from drinking any water exept that known to be pure.
7. Keep flies away from houses by clean conditions and periodic spraying with insecticides.
8. Attend to all animals as soon as unusual appearance or behaviour is noticed.
9. Isolate sick animals and suspects.

SIGNS OF HEALTH

The healthy animal stands well on its four feet, has a glossy coat, alert eye and mixes with its fellows. It is eager for food and excretion is effortless and medium-soft. The skin is soft and pliable and can be gathered in the fingers. The muzzle is moist and cool.

The normal temperature of cattle is 101.5° F. (taken at the anus), but may vary a little above and below that figure. It is usually higher in young and pregnant animals and is raised by exertion. The pulse rate is about 50 per

minute, but also varies. Respiration rate is about 20 per minute, but becomes shallow and quick if the animal is heated by exertion or when in a warm stuffy building.

A slight catarrhal discharge from the nose is usually harmless, while periodic discharges, clear in colour, may be seen at the vulva of the healthy cow.

Symptoms of Ill Health

An animal in poor health is dejected and stands with back arched and the rear legs drawn in. The hairs of the coat are dull and stand out, giving the appearance described as harsh, or staring. The skin is hard and cannot be "gathered". The eyes are dull and disinterested. Sick animals reject food or merely toy with it, and seek seclusion.

Further signs of trouble are groaning, grunting and restlessness and, if the animal lies down, it assumes a "sprawled" position with the head drooping.

The above are general signs which may be seen at a glance. In order to find the seat of the ailment, the specific symptoms must also be considered.

The behaviour of animals does not always indicate the site, but many pointers exist for the observant herdsman. Cattle are not demonstrative, but may point to the locus of pain by looking towards the part or attempting to "paw" it with the hooves. A fall in milk yield is often the first indication of trouble.

Swellings are an obvious indication of abnormality. Surface injuries and pain within the body, provided it is not too deeply seated, may be felt by pressing with the fingers, when the cow recoils from the touch.

Diseases can be diagnosed correctly only by skilled veterinary examination, often aided by laboratory tests. Several diseases may promote the same set of symptoms, and the information given in the following table is of a general nature and is designed to enable the farmer to proceed correctly, pending skilled examination.

Disorder and Causes.	*Symptoms.*
Intestinal troubles caused by irritant foods, mild poisons and chills.	Diarrhœa and dirty flanks.

Disorder and Causes.	*Symptoms.*
Digestive ailments, through overfeeding and indigestible foods.	Grunting and, possibly, constipation. Rumination may cease.
Digestive ailments caused by over-laxative feeding, such as excess of succulents. oily or mouldy foods.	Frequent and soft, almost watery, fæces.
Deficiency diseases, through badly balanced feeding, lack of minerals, etc.	Depraved appetite, failure to progress, listlessness: malformation in long standing cases.
Udder diseases, arising from infection, wounds or chills.	Swelling and hardening of the vessel, abnormal milk. Standing with rear legs wide apart and "paddling" with rear feet. Reluctance to lie down.
Genital disturbances, injury or infection.	*Females.* Absence of heat, sterility, inflammation, discharges and "paddling" rear feet. Arched back. *Males.* Swelling of scrotum and penis. Inflammation. Unwillingness to mount.
Respiratory diseases—congestion, chills, tuberculosis.	Shallow, quick breathing, often harsh sounding. Coughing; mucous at nose.
Parasites.	Coughing if in respiratory system. Punctures and skin irritations by those on or under the skin. General debility if parasites in digestive tract.
Fevers, caused by chills or the effects of other diseases.	High temperature, accelerated pulse and breathing. Dry muzzle.

An animal showing any of these symptoms should be isolated from the rest of the herd and kept in a warm, dry box. If necessary, it should be rugged for warmth. Except for scouring troubles, tempting, laxative foods such as bran mashes, linseed, lucerne and first quality hay should be offered, with molasses or locust bean meal as an extra appetiser when required. When scouring, costive foods must be given, and these should, of course, also be palatable. In winter, drinking water should be slightly warmed.

When the disorder is in the udder, forcing foods should be withheld and the cow milked at frequent intervals, but not stripped. The milk should be drawn into a bucket containing a strong disinfectant. The udder should be soothed with hot water cloths and gently massaged.

Classification of Diseases

The various forms of disease may be classified as follows:—

Epidemic Diseases
Nutritional Ailments
Colds
Parasites
Injuries

Epidemic diseases are the most dangerous as they are, of course, contagious, and may travel through the herd while the source of infection remains undiscovered. These diseases are communicated by one animal to the other and may be brought to the farm by vermin, dogs, birds, visitors and by the farmer himself after a visit to market.

The introduction of new animals may bring infection. To avoid this, new stock should not be bought in the open market but from farms known to be healthy. Infection may be picked up when travelling in a contractor's float and the ideal way to move stock is in one's own conveyance. In any case, all animals brought to the farm should be isolated for a few weeks before joining the others and should, preferably, be attended by one whose normal duties do not involve contact with the general herd.

The observance of these points, coupled with hygienic conditions, will do much to keep trouble at bay.

The most dangerous and common of the epidemic diseases are tuberculosis, contagious abortion, foot and mouth disease, Johne's disease and mastitis. Trichomones infection can be communicated only at mating.

Nutritional ailments are less dangerous, as adjustment of the diet will normally rectify matters.

Colds and chills arise from damp and draughty conditions. More serious diseases such as mastitis, tuberculosis and pneumonia may arise if conditions are not improved.

Parasites attack both internally and externally, and are not easy to remove once they have a grip. Clean houses and pastures are the best preventives.

Injuries may be caused by cows slipping on floors, standing on each other when rising and by horning. Injuries which are simple in the first place may have serious consequences if they are not attended to.

Means by which Animals are Infected

Disease may enter the body via the respiratory and digestive systems, the genitals, and through the eyes, wounds and bruises.

Diseases

The more common diseases and their treatment are listed below, but this chapter is in no way intended to replace the veterinary surgeon. Only the minor ailments such as external parasites, digestive disorders and chills which have not progressed too far may be safely treated by farm methods. The common ailments of calves (scour, indigestion and blackleg) and conditions causing sterility, are not described here, as they have been discussed in the appropriate chapters.

Epidemic Diseases

Foot and Mouth Disease. This is a scheduled disease, for which no treatment is permitted. It is caused by a filterable virus (even smaller than bacteria) and is highly contagious. While infected animals usually recover, they

are left in such a debilitated condition as to be useless commercially. The virus enters by mouth and inhalation and, besides direct contact, may be carried by man, dogs, birds or anything that has been exposed to the organism. The incubation period is one to ten days.

Symptoms. The temperature rises, animals go off feed, salivate and lie down. Blisters appear on the mouth and gums and on the skin above the hooves. Animals become lame and are obviously in severe pain. The blisters burst and leave a smooth, red surface.

Procedure. If the disease is suspected, the police must be informed immediately. They advise the official veterinary officers and if the disease is confirmed by them, the entire stock of cloven-hoofed animals is destroyed and the carcasses burned, even though all may not be infected at the time of examination.

The farm is isolated and put under the control of the Ministry vets. The movement of stock within a radius of fifteen miles is prohibited.

Several recent outbreaks have been traced to the feeding of unboiled swill to pigs, and dairy farmers feeding pigs in this way must obey the Law and boil swill for at least one hour before feeding.

Tuberculosis. A major scourge amongst domesticated animals and especially severe in dairy stock. The germs are ever present and ready to attack susceptible and debilitated animals. There are three types of tuberculosis—bovine, human and avian, and it is by the first of these that cattle are usually infected. Humans, especially children, are now known to be susceptible to bovine tuberculosis, while diseased workers can transmit the condition to cattle. It is therefore essential that herds be freed of the disease and that all who work with cattle be sound in health.

Tuberculosis is communicated from one animal to the other and is picked up by inhalation, ingestion and via cuts. The bacillus can live for some months outside the body and may thus remain a source of danger on pasture which has been grazed by infected animals.

Symptoms. The disease can settle in lungs, bones, glands or any other organ, and the symptoms vary accordingly. The advance is slow, so that, without veterinary tests, its presence may remain undetected until

the animal is slaughtered (which is more likely to happen in males and fattening stock), as the strain of calving and milking accelerates the disease in females. Generally, the symptoms are listlessness, loss of flesh and, if present in the lungs, coughing. After calving, a cow may lose condition rapidly.

Diagnosis by ordinary methods is impossible in many cases and the authorised test is the Double Intradermal Tuberculin Test. Tuberculin is injected into the skin, usually at the neck. The injection is repeated in 48 hours, and the thickness of the skin, measured before injection, is compared with the measurement after the injections are completed. Swelling means that the animal is infected, or, as is termed, a reactor.

Treatment. This is not economically possible. Cows found to have T.B. in the udder or any form of the disease in an advanced state must be slaughtered.

Housing of stock assists in the spread of tuberculosis, and the keeping of stock in covered or part covered courts, where the passage of air is free, is the best preventive.

Johne's Disease. The seat of this disease is the intestine. It is carried in dung and on pastures grazed by infected stock. Infection is most common in younger animals, and some districts appear to be more affected than others

Symptoms. The advance is slow and the disease is well advanced before symptoms become apparent. A typical case might be of a heifer whose first lactation was lower than was expected, to be followed by a still poorer one. Wasting and scouring then become evident. An animal reacting in this way probably contracted the disease during the calf or store period.

Treatment. None known. Infected animals are slaughtered and contaminated pastures ploughed up.

Mastitis. Mastitis means inflammation of the udder, and some confusion exists among farmers, as the term covers a number of diseases. Forms of mastitis result from invasions by streptococci, staphylococci and tuberculosis—the latter being, fortunately, rare. Disease may be in acute form when the animal may die, or chronic.

Mastitis causes great loss and is best prevented by good management, careful milking and clean conditions. Disease may flare up as a result of wounds, chills and knocks. Dr. Hammond (*Farm Animals*—Edward Arnold & Co.)

finds that a predisposition to mastitis may be inherited, so that breeding becomes a factor in its control. Overstocking udders (as is often done for sales) is another known cause.

As knocks are a known cause, it seems apparent that milk cows should not be brought in by dogs chasing them so that they are driven to a run and udders swaying and being knocked by the thighs.

Symptoms. The first symptom is usually the appearance of clots in the milk, easily detected when a strip-cup is used. The udder hardens, swells, and becomes discoloured and pained. The milk drawn becomes progressively more abnormal. In summer mastitis, which may attack dry cows and heifers, and is often fatal, pus may be drawn from the teats.

Treatment. Suspects should be isolated at once and veterinary aid called. When a particular type of mastitis is prevalent, the vet will usually instruct the farmer on the routine to be followed, so that, with intelligent application, subsequent treatment can be given at home. Treatment must not be delayed, as it is possible for the milk producing cells to be damaged beyond recovery, so that the quarter is permanently lost.

All wounds appearing on teats and udders should be immediately attended to, as they provide an easy source of entry for bacteria.

It is interesting to recall that a farm manager remarked to the writer that mastitis is "overrated in importance". In his case, the statement is probably true as he is a good manager, and the remark throws an interesting side-light on the freedom which often accompanies good management.

Trichomonas Infection. This is a venereal disease, being communicated only at mating. It is highly infectious and, where encountered, entails severe loss.

Symptoms. The bull may discharge from the penis, but this is not always evident. In cows, sterility or abortion result. After mating, a discharge appears at the vulva and the cows return to heat. Should they conceive, the calf is aborted any time up to the fourth month. If aborted in the first few weeks, it could be unnoticed, as the calf is then very small.

Treatment. Treatment of bulls is only justified in costly animals, others being slaughtered. Cows respond to veterinary measures, but a considerable time must elapse before a bull is put on to them, as the infection may not be completely cleared. When it appears that the cows are again normal, they should be inseminated artificially. If they conceive and carry their calves for the full term, they are cured, but if A.I. fails, treatment should be repeated.

Growmore Leaflet No. 90 (Ministry of Agriculture) warns that Trichomonas should be suspected when females constantly return to service, or return to heat two to four months after service.

Contagious Abortion. Causes great loss to dairy farmers. It follows an unusual course and is highly infectious. Infection via mouth, wounds and, it is believed, through the skin, and may be carried by the usual agencies—dogs, food, water, etc.

Young females exposed to infection are usually able to resist it. When the disease becomes active, the cow aborts at six or seven months. She will usually carry subsequent calves successfully, but remains a source of infection to other animals which have not built up resistance. When the disease first attacks a farm, many of the cows abort, but the following pregnancies are normal. Any heifers or new cows introduced will, in turn, abort, and then become apparently normal. And so the cycle goes on.

Symptoms. None apparent until the cow aborts at six or seven months. Cows may be tested by the Agglutination Test (blood test) and if reactors are disposed of, the herd may be kept clear.

Treatment. Aborted calves and the fœtal membranes, which are expelled with the calf, are highly infected and should be burned or buried deep in the ground. The cow should be kept isolated until all discharges have stopped and, of course, the calving box should be disinfected and all bedding burned. Although an infected cow has recovered sufficiently to bear a normal calf, the organisms causing the disease remain, and precautions similar to those for an aborting cow should be taken

To control the disease, calves should be vaccinated at four to eight months, when they will remain immune up to their third calf, and possibly later. Vaccination is

advised even where infection is not present, and when infection exists, cows should be similarly treated before mating.

Females which have aborted must not be sold within two months unless the fact is stated in writing to the purchaser. In any case, they cannot be exposed for sale in public markets and sales, and must not be put on to common grazing land, or land which is not properly fenced. Similarly, they must not be sent to be served by a bull belonging to another farmer, unless he is warned of the position.

When buying stock, a certificate showing that the animal has passed the agglutination test should be asked for. This is, however, insufficient of a guarantee, as infection may have been contracted in the interval, and the animal should be isolated for a few weeks and then tested again.

Nutritional Ailments

Milk Fever. Occurs shortly after parturition and is caused by the exhaustion of the available calcium in the body. The cow draws heavily on the available supplies to keep up the calcium content of the milk, and when the reserve is used, she collapses.

Symptoms. The cow becomes excited, staggers, and finally collapses. When lying down, the head is held awkwardly, looking backwards. Finally, collapse is complete and the cow lies stretched out and unconscious. If veterinary help is not called quickly, she will die.

Treatment. Previously, the udder was inflated, but the ruling method now is to give calcium injections. Recovery is rapid, but for some days the udder should not be milked right out.

To avoid recurrence of the condition, the calcium and Vitamin D level of the diet should be considered and stripping avoided for the first few days after calving. It is said that allowing the calf to suck for the first few days reduces the incidence.

Bloat or Hoven. Appears to result from grazing on pastures rich in wild white clover. Moisture is believed to be a contributing factor.

Symptoms. The body swells enormously, and if not treated, the animal rolls on to its back and dies.

Treatment. If caught early, the accumulated gas causing the swelling may be expelled by pommeling the animal's sides, or by medicinal treatment. In bad cases, the rumen must be punctured to allow the gas to escape.

Animals grazing on suspected pasture should be watched carefully and any showing signs of bloat should be instantly treated. Such pastures should not be used for night grazing.

PARASITES

When dealing with parasites, it is essential to know the life cycle of the pests so that treatment can be timed properly.

Ox Warble Fly. A large fly with yellow bands. It attacks cattle in still, sunny weather during May to August and lays its eggs on the hairs, generally on the lower parts of the body and the legs. In a few days the larvæ hatch out and burrow through the skin of the host. They travel through the body and congregate for a time at the gullet, eventually reaching the back in January or early spring. Eruptions are raised and in two to three months, the larvæ pass out through the skin and fall to the ground. In a little over a month they develop into flies and the sequence begins again.

Symptoms. The fly does not bite, yet cattle are reported to panic when it is about, though some authorities hold that this is not so and that stampeding is caused only by biting flies. The real symptom is the appearance of lumps along the back in early spring, and if these are squeezed, the larvæ are forced out. When the lumps appear, infested animals become restless.

Loss is occasioned by damage to hides and carcasses. As a result of irritation, yields are reduced and progress slows down. Infestation is more severe in animals kept outside.

Treatment. Treatment is given when the lumps appear on the back. The lumps should be rubbed with a mixture of powdered derris and soap in water, when the solution penetrates the breathing holes made by the grubs.

The Warble Fly (Dressing of Cattle) Order, 1948. This order, similar to the one suspended at the outbreak of war, stipulates that infested cattle be treated with a mixture made of 1½ ozs. derris resins or ½ oz. rotenone and 4 ozs. soap, mixed in 1 gallon water. This dressing must be applied not later than 22nd March or as soon as the maggots appear and must be continued at intervals of 32 days until 30th June, or longer if maggots persist.

The Ministry of Agriculture (Growmore Leaflet No. 95) warns against allowing the dressing solution into streams, as it poisons fresh water fish.

Husk or Hoose. Worms causing this trouble are picked up from grass. In the bronchial tubes they grow to maturity and propagate. The animal coughs and great numbers of larvæ are spread on the pasture where, in about two weeks' time, they grow to the stage at which they, in turn, cause infection. Calves and yearlings are most susceptible, but adults are not completely immune.

Symptoms. Frequent coughing, and in severe cases, condition is lost and the animal may die.

Prevention. The worm is found most commonly on wet pastures. When the grass is wet, the worm mounts the leaves, and retreats to the soil when the grass dries. Young cattle should be kept in, especially in autumn, until the grass dries. Infection is serious only when large numbers of worms are involved, and where pasture is known to be moderately infected, mature cattle may be put to graze it. If many worms are present, cattle should be withdrawn in favour of sheep. When fields are infested, they should be grazed lightly as, with fewer animals, not so many worms are likely to be picked up to complete their development.

Treatment. Infected stock should be removed from danger and built up in health so that they are able to throw off the effects. Severe cases may respond to veterinary treatment.

Ringworm. Often attacks young stock, causing hairless patches.

Treatment. Small eruptions appear on the bared skin These should be broken by rubbing and iodine ointment rubbed well in. Care should be taken in treatment as the pest may be communicated to the attendant. Houses,

and particularly any objects used as a "scratching" post, should be disinfected.

Lice. Cattle are occasionally infected by lice.

Treatment. Derris dust applied to the coat will kill the lice, but not the eggs. These hatch out in a few days and are destroyed if the treatment is repeated in 10 days. Lice most frequently appear along the back. When cattle are housed in autumn, many farmers clip the hair along the spine, as this tends to keep lice from developing. It also reduces sweating in the animal.

Chills

Chills, if not treated, may lead to more serious trouble. Any animal suffering in this way should be housed in a fresh, well ventilated loose-box. The temperature should be kept even and, in cold weather, water should be slightly warmed before being offered for drinking.

Wounds

Serious wounds should be treated by a vet. Cuts and abrasions should be bathed with a mild disinfectant and the animal kept away from the dangers of flies until the wound is healed.

If cows are turned out in cold weather with wet udders and teats, "chapping" results and the tiny wounds provide easy entry for disease germs. Udders should be thoroughly dried after washing and the teats treated with an ointment such as a mixture of vaseline and zinc ointment.

Teats

A hard obstruction within the teat canal sometimes results from the accumulation of mild "deposits", lime being the main constituent. These "peas" as they are called, should be removed only by the vet.

Warts are a fairly common occurrence and may be removed by winding a silk thread tightly round the root.

Ropy Milk. When this trouble is present, milk drawn

from a container appears like string. Similar "strings" may be seen adhering to the cooler and other utensils.

Infection is usually carried by water, either on the cow or directly to the utensils when washing. The responsible organism may reach the teats of cows when wading in ponds or lying on marshy ground. If the washing water is infected, the trouble only becomes apparent when the milk has been in contact with utensils.

To find the source, milk must be examined at each stage of the milking routine and if it is clear when it leaves the cow, then the washing water must be suspected. At whatever stage it appears, only a change to a fresh source of water and complete cleanliness of the cows and the thorough sterilisation of all utensils will clear it.

Summing Up

In concluding this chapter, it must again be emphasised that the veterinary surgeon is the only person capable of diagnosing and treating diseased animals. Immediate skilled examination of a sick animal may not only save the individual, but may save the whole herd from infection.

Veterinary science has advanced greatly of recent years and many cases of disease and sterility can be cured.

SCHEME FOR THE CONTROL OF DISEASES IN DAIRY CATTLE

The Ministry of Agriculture has introduced a panel scheme with the object of controlling mastitis, sterility, Johne's disease and contagious abortion. Small, fixed fees are payable by the farmer for the service. Farmers not availing themselves of this scheme should consult an official veterinary surgeon, or their own practitioner, for details.

Further reading. *Black's Veterinary Dictionary*—A. & C. Black.

Good and Healthy Animals—D. Paterson, English Universities Press, Ltd.

Various Bulletins as issued by the Ministry of Agriculture.

CONCLUSION

DETAILS of regulations and costs have been omitted as far as possible from this book, as they change frequently. Farmers should keep in touch with their local Agricultural Executive Committee, Livestock Officers and the Milk Marketing Board for advice on current procedure, while for costings, the Agricultural Colleges and the Ministry of Agriculture issue periodic survey reports which provide valuable information.

The prices paid for agricultural products, are, for the most part, controlled, and, apart from qualifying for quality bonus payments, there is nothing that the farmer can do to improve his earnings by searching for a better market. His one means of raising his profit is to increase the quantity of saleable products for every £100 he lays out.

It is now clear that most of our food must be home produced. But home produced food is at present too dear, and only better farming methods can reduce the cost to the consumer, while leaving the farmer with a fair profit. The cheaper food is, the better balanced our national economy will be.

The two items which mainly influence the cost of milk are the yields of the cows and the amount of home grown food available to them and its cost.

Surveys have shown that cost of production per gallon falls steadily as the yield rises to what may be described as the "commercial ceiling". Thus, the decline in costs per gallon is steady as yields climb to about 1,000 gallons, after which the tendency is for a slight rise. The total cost of keeping the cow rises, naturally, with the yield, but does not keep pace with the increased income.

From a group of recent surveys, the total cost of keeping a 500 gallon cow is shown to be about £45 per year, while for an 800 galloner, it is approximately £55. Taking milk at an average price of 2s. 3d. per gallon, the return

from the 800 gallon cow exceeds by £34 that from the lower producer, the surplus being, of course, obtained for the additional expenditure of £10. Extending the total milk yields at 2s. 3d. per gallon, the 500 galloner brings in £56, which leaves a margin of £11, while the 800 galloner gives a net profit of £35.

The influence of cropping, especially when yields are mainly or wholly maintained on home grown foods, may readily be seen from the following comparison:—

NUTRIENTS PER ACRE

Crop	Yield per Acre	Dry Matter lbs.	PE lbs.	SE lbs.	Milk Equivalent considering production rations only. (Based on PE) Gallons	*Effective Milk Equivalent Gallons
Kale	15 tons	4,670	440	3,020	880	220
Kale	25 tons	7,786	725	5,020	1,450	362
Beans	15 cwts.	1,440	330	1,100	660	165
Beans	25 cwts.	2,400	550	1,843	1,100	275
Average pasture in spring	10 tons	4,480	480	2,500	960	240
Good grass rotational grazing	20 tons	8,960	1,080	6,000	2,160	540

* *Note.* The Hannah Dairy Research Institute has adopted 2 lbs PE as the effective milk equivalent. That is, when the feeding of young stock; the bull, dry cows and the total rations of milk cows are considered, 2 lbs. PE are required for each gallon of milk which leaves the farm. The figures are based on the findings of Leitch and Godden (Imperial Bureau of Animal Nutrition, No. 14, 1941) who concluded, that, considering the entire life cycle, the dairy cow is only about 20% efficient.

The accuracy of this system is shown by the "Hannah" results. For the full year, crops to provide the effective equivalent of 20,000 gallons were planned and sown. Crops to the value of 3,000 gallons of milk were sold off the farm and the actual production obtained was 18,585 gallons.

The PE expected from the crops was estimated by reference to Ministry of Agriculture Bulletin No. 124 (which is used in all calculations in this book), and from crop yields which could be obtained in the district. This system forms an excellent basis for crop planning.

Crop yields are, of course, governed to a great extent by soil and climate, but within the limits imposed by these conditions, there is little difference in the cost of growing

a poor crop and a good one. Accepting this, and taking beans as an example, it is seen that the good crop produces the nutrients necessary for each gallon at little more than half the cost of the poor one. Naturally, rotational grass involves greater expenditure than permanent pasture which receives little attention, but again, the additional yields far outweigh the extra costs.

The value of a crop may also be stated in terms of growth and beef production. An acre of good grass will, in a season, provide a fattening bullock with the food necessary for a liveweight gain of 250 lbs., whereas poorer fields may produce only 10—100 lbs. of beef per acre.

While good husbandry enhances the bulk of the crop, judicious manuring also increases the rate of nutrients per unit of weight. Thus, if a hay crop is given a dressing of nitrogenous fertiliser 2—3 weeks before cutting, the protein content is raised. Applied earlier in the season, 1 cwt. of such a fertiliser will increase the bulk by 5 cwts per acre.

These are only a few examples of cropping efficiency. The means of obtaining them do not come within the scope of this book, and text books on soils, manures, grass, and crops, should be consulted.

In some of the rations suggested in the foregoing chapters, several of the foods included are difficult to obtain at present, but their use is described because it is expected that they should gradually return to our markets. However, the available home grown foods have been fully shown and it is hoped that enough has been said to demonstrate that, on the majority of farms, all cows producing up to 3 gallons of milk daily, and in some cases more, can be fed from the farm. Moreover, if grass is treated as a crop, cows producing 3 to 4 gallons need have no more than good grass with, when the value falls, grass silage or dried grass and home grown bulky foods. Good grass is the cheapest and most productive of all crops.

The feeding of available foods according to the rationing system detailed in this book will ensure the most economic use being made of them. As an example of this, the writer was able to save a farmer £400 per year on the feeding of 35 dairy cows by overhauling the maintenance rations alone. The rations fed were not only unbalanced, but were over costly. On the other hand, a mistake frequently made on poorer farms is to overstock

with cattle, with the result that there is too little food for full production. It is much more profitable to get 2,000 gallons from three cows properly fed than from five which have to scrape for their food.

The battle for cheaper production is already half won. No longer does the farmer scorn the scientist, but he must quicken his pace in following the leads given. Education, particularly of young farmers and farm workers, is essential to this end and one wishes success to the efforts of the Universities, Colleges, Farm Institutes and the Ministry of Agriculture to put before farmers the latest findings. Theoretical knowledge alone will never make a farmer; practical experience only half of one. It is the combination of science and practice which makes the true worker and the man on whom the country relies

For their investigations and making their findings known, tribute is paid to those of all lands who have worked to further agricultural knowledge. Included particularly are those mentioned in above text and the authors of the books given in the bibliography for each chapter. These have been studied and are recommended to those who wish to know thoroughly the job of dairy farming. Others which cannot be listed under chapter headings are shown below.

Thanks are offered to the many farmers who have thrown their herds and their "secrets" open to the writer; their kindness will never be forgotten, and the following: Messrs. Alfa Laval Ltd., for provision of opportunity to study their latest milking machines and methods; to Mr. R. B. Maneely, M.R.C.V.S., for advice on the matter contained in Chapter XII and to the suppliers of the many fine photographs and drawings which illustrate the text; and to the editor of "Agriculture".

And finally, and very warmly, thanks to Dr. Hammond, who took an interval from the world-wide calls upon his time to read this book and write a Foreword. His earlier and generous encouragement to the author is also gratefully acknowledged.

APPENDIX 1

BOOKS FOR FURTHER READING

Agriculture, *The Science and Practice of British Farming*—James A. S. Watson and James A. More, Oliver and Boyd.

British Dairying—Frank H. Garner, Longmans Green & Co.

Soils and Manure—Sir E. J. Russel, Cambridge University Press.

The Ministry of Agriculture monthly journal *Agriculture* is also strongly recommended

APPENDIX 2

NUTRITIONAL VALUE OF FEEDING STUFFS

	Dry Matter per 100 lbs.	Equivalents Protein per 100 lbs.	Starch per 100 lbs
ROOTS			
Mangolds	10.7	0.4	6.8
Potatoes	23.8	0.9	18.5
Swede Turnip	11.5	0.7	7.3
Turnip	8.5	0.4	4.4
LEAVES OF ROOTS			
Mangold Leaves	11.0	1.3	5.3
Sugar Beet Tops	16.2	1.2	8.6
Swede and Turnip Leaves	11.6	0.9	5.3

	Dry Matter per 100 lbs.	Equivalents Protein per 100 lbs.	Starch per 100 lbs.
Other Green Foods			
Cabbage, drumhead	11.0	0.9	6.6
Cabbage, open leaved	15.3	1.5	9.5
Kale, thousand head	15.8	1.5	10.3
Kale, marrowstem (unthinned)	14.0	1.4	9.3
Kale, marrowstem (singled)	13.9	1.3	9.0
Rape	14.1	1.6	6.9
Cereals			
Barley in flower	31.4	1.4	16.1
Maize	19.4	0.8	9.1
Oats in flower	23.2	1.3	10.0
Grasses			
Pasture Grass, close grazing:			
Non-rotational	20.0	4.2	14.7
Rotational, with 3 weekly intervals*	20.0	3.5	14.6
Rotational, with monthly intervals*	20.0	2.5	13.4
Pasture Grass, extensive grazing:			
Spring value, running off during summer	20.0	2.1	11.2
Winter pasturage (after close grazing, allowing free growth from end July to December)	20.0	1.8	11.4
Ryegrass, perennial	24.8	1.5	10.6
Ryegrass, Italian	25.0	1.7	11.4
Timothy	33.1	1.3	14.0
Green Legumes			
Alsike	15.0	1.8	6.3
Crimson Clover	18.5	1.8	8.9
Red Clover, beginning to flower	19.0	2.1	10.2
White Clover, beginning to flower	18.5	2.4	8.8

* Data for fore-flush should be taken as for non-rotational close grazing.

	Dry Matter per 100 lbs.	Equivalents Protein per 100 lbs.	Starch per 100 lbs.
GREEN LEGUMES—*continued*			
Beans, beginning to flower	15.0	1.9	7.1
Kidney Vetch	18.0	1.0	7.9
Lucerne (early flower)	24.0	2.5	10.3
Lucerne (in bud)	22.0	3.0	11.3
Lucerne (before bud)	15.0	2.7	9.0
Peas, beginning to flower	16.8	2.0	6.8
Sainfoin, in flower	20.0	1.9	7.6
Tares or Vetches, in flower	17.5	1.8	7.5
MISCELLANEOUS			
Gorse	51.3	1.9	8.9
Heather	50.0	1.0	6.0
SILAGE			
Grass (first quality)	21.0	1.9	12.8
Grass (second quality)	24.5	1.5	12.6
Grass (hay maturity)	25.0	1.4	10.2
Lucerne	25.0	2.3	11.1
Maize	18.5	0.6	8.6
Maize, Jaune Gros, English grown	21.0	1.0	12.1
Mangold Leaves	22.4	1.4	7.9
Marrow Stem Kale	15.9	1.3	9.2
Oats, green	23.7	0.9	8.9
Vetch and Oats, green fruity	27.3	1.6	12.8
Vetch and Oats, acid brown	34.6	2.9	13.0
SWEET SILAGE			
Grass	32.0	1.3	13.0
Lucerne	27 5	2.1	7.7
Stack Silage, Ryegrass and Clover	32.2	0.5	10.5
HAY			
Clover, crimson, good	83.5	7.0	38.0
Lucerne, before flowering	84.0	10.1	32.0
Lucerne, in full flower	83.5	8.0	29.0
Lucerne, in half flower very good quality	84.0	11.8	37.1

	Dry Matter per 100 lbs.	Equivalents Protein per 100 lbs.	Starch per 100 lbs.
HAY—*continued*			
Meadow Hay, poor	85.7	3 0	22.0
Meadow Hay, good	85 7	4 6	37.0
Meadow Hay, very good	84.0	7.9	48.0
Meadow Hay, aftermath, good	85.2	6.2	43.0
Meadow Hay, from wet meadows	85.0	6.7	45.0
Ryegrass, perennial	86.0	5.8	38.8
Ryegrass, Italian	86 0	6.2	44.3
Tares, beginning to flower	83.3	12.9	35.0
Tares, in full flower	83.3	8.0	32.0
Tares and Oats, tares in flower	84.0	5.4	34.0
Timothy	85.7	3.6	35.0
Seeds Hay, Ryegrass and Clover	86.0	4.9	29.0
STRAWS			
Barley Straw, spring	86.0	0 7	23.0
Bean Straw, including pods	86.0	1.7	23.0
Oat Straw, spring	86 0	0.9	20.0
Oat Straw, winter	86.0	0.5	21.0
Tare or Vetch Straw	86 7	3 6	15 0
CEREALS			
Barley	85 1	7.3	71.4
Maize	87 0	7 7	77.6
Oats	86.7	7.6	59.5
Wheat	86.6	9.6	71.6
LEGUMES			
Beans	85.7	19.7	65.8
Peas	86.0	18.2	69.0
Vetches	86.7	21.4	69.7
OIL CAKES AND MEALS			
Coconut Cake	88.6	16 4	76.8
Coconut Meal	88.7	15.1	73.6
Cotton Cake, Bombay	87.7	15.1	40.0
Cotton Cake, Brazil	89.0	20.3	42.0
Cotton Cake, Egyptian	87.9	17.3	41.6

	Dry Matter per 100 lbs.	Equivalents Protein per 100 lbs.	Starch per 100 lbs.
OIL CAKES AND MEALS—*continued*			
Cotton Cake, decorticated	90.2	34.6	68.4
Cotton Seed Meal	91.3	36.8	70.1
Ground-Nut Cake, decorticated	89.7	41.3	73.0
Ground-Nut Cake, undecorticated	89.7	27.2	56.8
Ground-Nut Meal, undecorticated, extracted	92.4	28.7	44.4
Linseed Cake, English made	88.6	24.6	74.0
Linseed Cake, foreign	89 0	27.1	74.5
Linseed Meal, extracted	88.3	30 4	63.7
Maize Germ Meal	89.2	10.3	84.3
Maize Flaked	89.0	9.2	84.0
Palm Nut Kernel Cake, English made	89 0	17.0	73.2
Palm Nut Kernel Cake, imported	90.3	13.9	81.7
Palm Nut Kernel Meal, extracted	90 0	16.5	71.3
Soya Bean Cake	85.6	36.9	68.9
Soya Bean Meal, extracted	88 7	38.3	64.0
Sunflower Cake, decorticated	90.4	32.6	72.5
BY-PRODUCTS			
Barley, brewers grains, fresh	32.4	5.4	18.4
Barley, brewers grains, dried	89.7	12.5	48.3
Barley, distillers grains, fresh	26.2	6.0	16.2
Barley, distillers grains, dried	92.0	19.2	57.2
Barley, ale and porter grains, fresh	27.0	4.6	14.8
Barley, ale and porter grains, dried	90 7	13.6	49.2
Malt Coombs	90.0	16.0	43.4
Blood Meal	80.0	68.2	62.9
Fish Meal, white	87.0	53.0	58.9
Grass, dried, frequently cut	90.0	15.6	65.7
Grass, dried, less frequently cut	90.0	11.1	60.3
Lucerne Meal (from crop just coming into flower bud)	91.0	13.6	50.1
Lucerne Meal, English (from crop in early flower)	91.0	10.5	44.1

	Dry Matter per 100 lbs.	Equivalents Protein per 100 lbs.	Starch per 100 lbs.
BY-PRODUCTS—*continued*			
Maize, bran	88.2	5.2	67.0
Maize, gluten feed	89.6	19.2	75.6
Maize, malt coombs	86.5	14.0	59.4
Meat Meal (low fat)	93.0	51.0	59.6
Milk, buttermilk	9.2	3.4	9.2
Milk, cow's, whole	12.8	3.2	17.1
Milk, separated	9.4	3.3	8.3
Milk, skimmed, deep set	9.7	3.3	9.1
Milk, skimmed, shallow set	10.0	3.3	9.8
Milk, whey	6.6	0.6	6.1
Milk, colostrum (first drawn)	25.5		
Milk, dried, whole	95.8		
Milk, dried, separated	89.7		
Milk, whey paste	46.0		
Milk, dried whey	92.2		
Oat meal } from preparation	90.5	3.8	45.5
Oat bran } of oatmeal	91.8	11.2	61.5
Sugar Beet Pulp, wet	15.0	1.0	11.7
Sugar Beet Pulp, dried	90.0	5.2	60.6
Sugar Beet Pulp, molassed	90.0	4.6	58.3
Sugar Beet Molasses	74.7	1.2	51.6
Sugar Cane Molasses	74.2	1.1	50.6
WHEAT FEEDS			
Pure Grades			
Finest Grade, fine middlings	86.7	12.1	69.0
Second Grade, coarse middlings or sharps (fine wheat feed)	86.0	10.8	56.5
Fourth Grade, bran	87.0	9.9	42.6
Broad Bran	87.0	10.0	42.6
Yeast, dried	95.7	40.7	67.2

These tables are extracted from the Ministry of Agriculture Bulletin No. 124, and are reproduced by permission of the Controller, H. M. Stationery Office.

Mineral Composition of Some Common Feeding Stuffs

	Total Ash	Lime (CaO)	Phosphoric Acid (P_2O_5)	Potash (K_2O)	Chlorine (Cl_2)
	per cent.	per cent.	per cent.	per cent.	per cent.
Mangolds	0.9	0.02	0.09	0.45	0.16
Swedes	0.7	0.08	0 08	0.30	0.04
Cabbage	1.2	0.20	0.15	0.40	0.02
Kale, thousand head	1.7	0.39	0.13	0.52	0.16
Kale, marrow stem	1.9	0.43	0.12	0.55	0.21
Sugar Beet Tops	3.4	0.34	0.11	0.58	?
Pasture Grass (rotational close grazing)	2.0	0.28	0.16	0.60	0.19
Grass Meal (18% Protein)	8.8	1.20	0.75	2.70	0.80
Clover, red, flowering	1.6	0.40	0.15	0.50	0.05
Lucerne (before bud)	1.8	0.45	0.13	0.48	0 05
Lucerne (in bud)	1.8	0.77	0.14	0.56	0.05
Lucerne (early flower)	2.4	0.96	0 12	0.43	0.08
Lucerne Meal	9.2	2.73	0.78	1.82	0.55
Meadow Hay, good	6.2	1.00	0.43	1.60	0.37
Seeds Hay	6.3	2.00	0.60	1.80	0.30
Lucerne Hay (half flower)	8.0	2.74	0.51	1.52	0.34
Oat Straw	4.9	0.36	0.18	1.50	0.30
Barley	2.6	0.07	0 84	0.57	0.12
Maize	1.3	0.02	0 82	0.40	0.07
Oats	3.1	0.14	0.81	0.55	0.07
Wheat	1.7	0.05	0.86	0.60	0 08
Beans	3.2	0.18	0.88	1.28	0.03
Peas	2.8	0.10	0.90	1.00	0.04
Bran	5.8	0.20	2.80	1.50	0.09
Weatings	3.7	0.13	1.50	1 40	0.07
Coconut Cake	5.4	0.50	1.50	2.00	?
Cotton Cake, undec.	5.8	0.30	2.50	1.60	0.05
Cotton Seed Meal	6.0	0.36	2.70	1.60	0.04
Ground-Nut Cake, undec.	5.7	0.20	1.00	1.10	
Ground-Nut Cake, dec.	5.8	0.20	1.30	1.50	0.03

	Total Ash	Lime (CaO)	Phosphoric Acid (P_2O_5)	Potash (K_2O)	Chlorine (Cl_2)
	per cent.	per cent.	per cent.	per cent.	per cent.
Linseed Cake	5.2	0 51	1.70	1.30	0.09
Palm Kernel Cake	3.8	0.30	1.10	0.50	0.16
Soya Bean Cake	5.4	0.30	2.00	1.80	0 03
Soya Bean Meal, extr.	5.5	0.30	2.10	1.90	0 03
Fish Meal, White	22.0	10.00	9.00	1.20	1.00
Meat Meal, Pure	3.8	0.40	0.70	0.10	0.27
Meat Meal	19.0	8.00	7.20	0 70	1.20
Meat and Bone Meal	24.0	10.50	9.30	0.80	1.40
Blood Meal	2.7	0.05	0.22	0.31	0.85
Yeast, dried	9.6	0.30	5.50	2.00	0.03
Milk, whole	0 8	0.17	0.20	0.20	0.10
Milk, separated	0.8	0.15	0.20	0.20	0.10
Whey	0.7	0.10	0.10	0.15	0.07
Brewers Grains, dried	3.9	0 40	1.60	0.20	0.06
Distillers Grains, dried	1.8	0 40	0.68	0.20	0.06
Locust Bean Meal	4.0	0.85	0.26	0.70	0.20
Maize, flaked	0.9	Trace	0.60	0.25	Trace
Maize, Germ Meal	3.6	0.10	0.90	1.30	?
Maize Gluten Feed	2.5	0.10	0.70	0 20	?
Sugar Beet Pulp, dried	3.1	1.20	0.18	0.59	0.05
Sugar Beet Pulp, molassed	5.5	1.20	0.17	1 34	0.48
Steamed Bone Flour (dry matter)	88.7	45.80	31.10	?	?

The sign ? indicates absence of data.

Information extracted from the Ministry of Agriculture Bulletin No. 48, and reproduced by permission of the Controller, H. M. Stationery Office.

APPENDIX 3

GRADES OF MILK

The Special Designations at present in force are:—

Tuberculin Tested.
Tuberculin Tested (Certified).
Accredited
Pasteurised.

Certain bonuses are payable on the better grades and on the milk of Channel Island herds. In the latter case, the farmer is entitled to the bonus only if he can find an outlet at the higher prices.

These matters are not gone into in detail here, as it is possible that by the time this book is published, a new scheme will rule. The reader requiring information on these points should get in touch with his local Agricultural Executive Committee, who will give advice.

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